This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

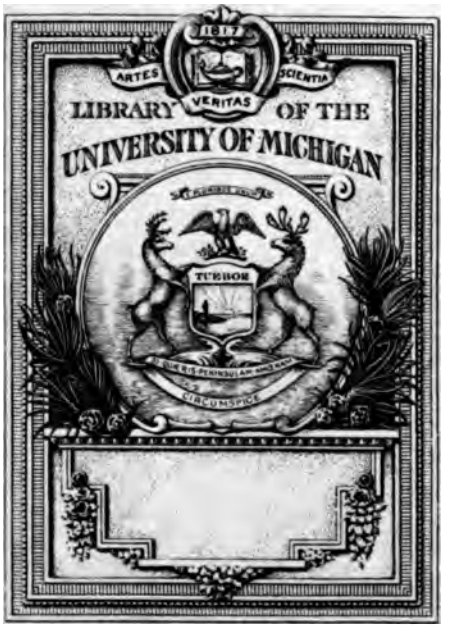
We also ask that you:

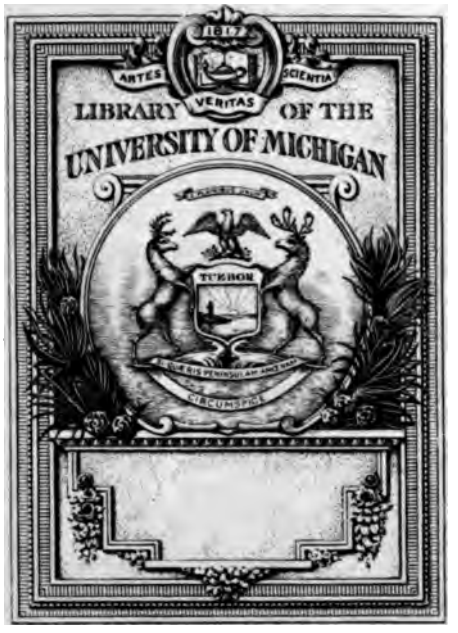
+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 938,257


1817
ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE


ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE

AS
36
.W8

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS.

VOL. V. 1877-81.

PUBLISHED BY AUTHORITY OF LAW.

MADISON, WIS.:
DAVID ATWOOD, STATE PRINTER.
1882.

OFFICERS.

PRESIDENT.

ROLAND D. IRVING, E. M., Ph. D., Professor of Geology, University of Wisconsin.

VICE PRESIDNT, DEPARTMENT OF SCIENCES.

T. C. CHAMBERLIN, A. M., U. S. Geologist, Director Geological Survey of Wisconsin.

VICE PRESIDENT, DEPARTMENT OF LETTERS.

WESLEY C. SAWYER, Ph. D., Professor State Normal School, Oshkosh.

SECRETARY.

E. A. BIRGE, Ph. D., Professor of Zoology, University of Wisconsin.

LIBRARIAN.

A. O. WRIGHT, M. A., Secretary Wisconsin State Board of Charities and Reform, and Recording Secretary National Conference of Charities and Corrections.

CURATOR OF MUSEUM.

R. C. HINDLEY, Professor Racine College.

TREASURER.

Hon. S. D. HASTINGS, Madison.

TABLE OF CONTENTS.

DEPARTMENT OF LETTERS.

I. THE ENGLISH COTTAGERS OF THE MIDDLE AGES — by *Prof. W. F. Allen*, State University, Madison 1

II. THE PHILOSOPHY OF HISTORY — by *Prof. A. O. Wright*, Wisconsin Female College, Fox Lake (now Secretary State Board of Charities and Reform, Madison) 12

III. LIFE INSURANCE, SAVINGS BANKS, AND THE INDUSTRIAL SITUATION — by *Rev. Charles Caverno*, Lombard, Ill 21

IV. DISTRIBUTION OF PROFITS, A NEW ARRANGEMENT OF THAT SUBJECT — by *Prof. A. O. Wright*, Fox Lake 38

V. WEALTH, CAPITAL AND CREDIT — by *Prof. J. B. Parkinson*, State University, Madison 46

VI. THE NATURE AND FUNCTIONS OF CREDIT — by *Pres. A. L. Chapin*, D. D., Beloit College, Beloit 57

VII. NATURE AND THE SUPERNATURAL — by *Prof. J. J. Elmendorf*, S. T. D., Racine College, Racine 66

VIII. FIRST FRENCH FOOT-PRINTS BEYOND THE LAKES — by *Prof. J. D. Butler*, LL. D., Madison 85

IX. THE PHILOSOPHY OF F. H. JACOBI — by *Prof. W. C. Sawyer*, Lawrence University, Appleton (now of the State Normal School, Oshkosh) 146

X. THE "*Ἅπαξ Λεγόμενα* OF SHAKSPERE — by *Prof. J. D. Butler*, LL. D., Madison 161

DEPARTMENT OF SCIENCES.

XI. A LIST OF THE CRUSTACEA OF WISCONSIN — by *W. F. Bundy*, M. D., Sauk City (now professor Eclectic Medical College, Chicago, Ill 177

XII. THE CORALS OF DELAFIELD — by *Ira M. Buell*, Beloit 185

XIII. ON SOME POINTS IN THE GEOLOGY OF THE REGION ABOUT BELOIT — by *G. D. Swezey*, Beloit (now professor in Doane College, Crete, Neb) 194

XIV. THE TIDES — by *Capt. John Nader*, Madison 207

XV. On a Proposed System of Lithological Nomenclature — by *Prof. T. C. Chamberlain*, Ph. D., Beloit College, Beloit; also State Geologist 234

XVI. Menobranchus Lateralis — by *P. R. Hoy, M. D.*, Racine ... 248

XVII. The Pipestone of Devil's Lake, by *Hon. E. E. Woodman*, Baraboo 251

XVIII. The Larger Wild Animals that Have Become Extinct in Wisconsin — by *P. R. Hoy*, M. D., Racine 255

XIX. Observations on the Recent Glacial Drift of the Alps — by *Prof. T. C. Chamberlain*, Beloit, State Geologist..... 258

XX. Temperature of Pine, Beaver and Okanchee Lakes — by *Elizabeth M. Gifford* and *Geo. W. Peckham*, Milwaukee 273

XXI. A Description of Some Fossil Tracks from the Potsdam Sandstone—by *Prof. James E. Todd*, Beloit College, Beloit. 276

XXII. A Chapter on Foundations — by *Capt. John Nader*, Madison 282

XXIII. Primitive Architecture in America — by *Rev. S. D. Peet*, editor American Antiquarian, Clinton 290

ADDENDA.

Proceedings of the Academy from December 27, 1878, to July 5, 1881.. 321

Librarian's Report, with catalogue..... 335

List of Members..... 359

DEPARTMENT

OF

LETTERS.

DEPARTMENT OF LETTERS.

THE ENGLISH COTTAGERS OF THE MIDDLE AGES.

By Prof. W. F. Allen.

In the statute entitled *Extenta Manerii*, enacted in the fourth year of Edward I. (1276), three classes of tenants of the manor are enumerated: the *libere tenentes* or freeholders; the *custumarii* or customary tenants; and the *coterelli* or cottagers. In former papers I have inquired into the origin of the two first of these classes, and attempted to show that the customary tenants were representatives of the primitive village community, and that the freeholders were of feudal origin. In the present paper I propose to consider the third class, the cottagers.

The class who, in this document, are called *coterelli*, are known by several other names — *cotagii*, *cotmanni*, *cotarii*, *coterii*, *cotlandarii*. The several manors enumerated in the Gloucester Cartulary use these terms indifferently, while the Domesday of St. Paul's, in a passage corresponding to that in the *Extenta Manerii*, uses the word *cotagii* instead of *coterelli*. The Exchequer Domesday has *coterii* and *cotmanni*, as well as a new variation, *cosceti* or *coscez*, and the laws of Henry I. also mention *cotseti*. Lastly, the *Rectitudines singularum personarum*, of the period before the Norman Conquest, has *cotsetlan*, a form which is repeated in the *consetl'* of the Abingdon Cartulary, in the latter half of the twelfth century.

Here are ten forms of the same word, evidently having the same derivation, and apparently the same meaning. Nor is there any difference discernible in their tenures and services. They generally hold a messuage and curtilage, that is a cottage with a yard, or an acre or two of land, and render therefor some trifling services. Still they occasionally are found with estates of considerable size; as, an entire virgate,[1] twelve acres,[2] ten, nine and

[1] Domesday of St. Paul's, p. 5.

[2] Boldon Book, p. 566.

so on.[1] Neither are we entitled to assume an absolute identity in the several terms, inasmuch as *cotarii* and *cosceti* are occasionally found in the same manor.[2] To add to the perplexity, Domesday Book regularly uses a word of entirely different etymology, *bordarii*, for the class of cottagers, the terms *cotarii*, *cotmanni* and *cosceti* being only occasionally used, and then being often found on the same estate with *bordarii*.

The differences here indicated were no doubt slight and unessential: and at any rate it would be a hopeless task to attempt at the present day to trace them in detail. Let us return to the threefold classification made by the *Extenta Manerii*; this classification evidently indicates broad and intelligible distinctions. We will inquire first into the position of the cottagers of the thirteenth century, and then proceed to trace the origin of the class. We are here at the start upon firm standing ground. The cottagers of the thirteenth century are sufficiently well understood: in order, however, to make their condition intelligible, a brief review of the previous history of the peasantry will be necessary.

The peasantry of the Germanic nations were, in the earliest times, divided into small communities, each occupying a definite tract of land, called *mark*, which they owned and cultivated in common. When they reached a more advanced stage of progress, which required the ownership of land in severalty, each member of the community received an equal portion of land, consisting of house-lot and arable land, with rights of user in the meadows, pasture and forest, which he held as his own, subject, however, to the methods of cultivation followed by the community. This share was called in England, *hide*, on the continent, *mansus*. At first the proprietor of the hide held it as it were in trust for his family; he could not alienate it, but must transmit it to his heirs. Soon, however,—at a very early time in England,—he acquired the right of alienation; and, as a matter of course, the primitive equality of ownership was speedily succeeded by great inequality. A few became rich, others were forced to dispose of a part, or

---

[1] Exchequer Domesday, i. f. 128.

[2] e. g., Carletone in Wiltshire. Id. p. 67.

even the whole, of their land. We have, therefore, rich peasants, poor peasants, and landless peasants.[1]

The name given to the village mark in Latin — the language almost universally used for public documents in the middle ages — was *villa*, and its inhabitants were *villani*. Now in the changes in landed property, so long as a man kept his hold upon his share (hide), or even upon any aliquot portion of it, he was by right a *villanus*, a "townsman," and entitled to all the political and economical privileges which belonged to the community. Thus, the manor of Sandun[2] gives first of this class those who held half a virgate (i. e., one eighth of a hide, the regular share having been reduced to this amount by successive subdivision), then the *operarii* of ten acres, and then those of five. These three classes were the *villani* proper, or, as they were now called, the *custumarii*, or customary tenants. They were the higher order of serfs, bound to labor by an hereditary obligation from which they could not escape; but having an interest in the soil, also hereditary, and of which they could not be deprived. Above them were the freeholders, *libere tenentes*, also having an interest in the soil, and held to labor; but an interest and an obligation resting upon definite and personal contract. But there was a class below the customary tenants; serfs, like them, held to labor by an obligation which they did not themselves enter into, and from which they could not escape, but having no interest in the soil to compensate for it. They might hold land, even in considerable amount; but it was purely at the will of the lord. These were the cottagers. If the customary tenants may be called *villeins regardant* (prædial serfs), the cottagers may be called *villeins in gross* (personal serfs), with a status hardly better than that of slaves proper. Both classes held their lands nominally "at will," but with the customary tenants the prescriptive rights of the tenant were effective against the bare legal right of the lord.

It will be noted that there were no slaves in England at this time (the close of the thirteenth century.) There had been at an

---

[1] See, on this point, Thudichum, *Gau und Markverfassung*, p. 211.

[2] Domesday of St Paul, p. 13.

earlier time, but they had been gradually emancipated, and were, of course, one element of the class of cottagers. Another element was the poorer or more shiftless members of the village community; however low they might sink, so long as they retained, by prescriptive right, a share in the mark, they were *villani*, or customary tenants; if they lost this, and were dependent upon the lord for grants of land, they were cottagers, tenants at will.

Personal status and tenure of land are two points of view from which every class of persons in the middle ages must be regarded. In treating of the changes in landed property, I have partly anticipated the companion topic of personal status. While the hide was subdivided, and while many members of the community were losing their share altogether, a parallel process was going on, by which the entire body of free villagers, *villani*, were transformed into serfs. And side by side with this was a process familiar to all students of social history — the converse process, by which the slaves were elevated in position and became personally free, while still held to obligatory labor. The common freemen, by a process of degradation, and the slaves, by a process of elevation, met on the common ground of serfdom, and were distinguished from one another, not by any difference in personal status, but by their relation to the land. The common freemen, the *villani*, were now villeins regardant; the landless freemen and the slaves were villeins in gross, or serfs proper. For it should be noted that the distinction made by modern law writers between villeins regardant and villeins in gross is not recognized by the law writers of the time, and must be considered as not at all a difference in personal rights, but in right to the land. *Quicumque servus est*, says Fleta,[1] *ita est servus sicut alius, nec plus nec minus.* The higher class were attached to the soil simply because they had a prescriptive and inalienable right to the soil; the lower class could be transferred from hand to hand or estate to estate like slaves, simply because their obligation to labor was not joined with a permanent right to a definite estate of land.

Therefore, we have a clue to start with — the two fold origin of

---

[1] Book I. 3. 3.

the cottagers. We must look to the slaves as well as to the landless freemen, for their source.

For assistance in this enquiry we must have recourse chiefly to two documents of the 11th Cent.; the *Rectitudines Singularum personarum*, which gives the obligations of three classes of free peasants shortly before the Norman Conquest; and the great or Exchequer Domesday Book, which gives the numbers, on every estate, of two principal classes, only in a few cases stating the extent of their tenure and their obligations. Both documents mention also slaves; but it must be undestood that the "slave" of this period was rather a serf than a chattel slave. It will be noted that the passage from Fleta, just cited, uses the word *servus* at a time (about A. D. 1300) when chattel slavery had been long abolished.

Our three principal documents therefore give us the following classification: the *Rectitudines singularum personarum*, three classes, *Geneat*, *Cotsetel*, and *Gebur*; Domesday Book, two classes, *Villani* and *Bordarii:* the *Extenta Manerii*, three classes again, *Libere tenentes*, *Custumarii* and *Coterelli*. Our problem is to reconcile these differences.

In the first place, it should be remarked that the *Libere tenentse* or freeholders, having come into existence since the time of Domesday Book, do not correspond to any one of the earlier classes, and may therefore be left out of account. In the next place, it is perfectly well established that the *Geneat* of the *Rectitudines*, the *Villani* of Domesday Book, and the *Custumarii* of the *Extenta Manerii*, are the same class. We have therefore only to determine the relation of the *Coterelli* to the others of these earlier classes; and especially to explain how it is that Domesday Book has only one principal class, the *Bordarii*, where a few years earlier there were two, the *Cotsetel* and the *Geburs*.

Here I must call to mind the fact to which I directed attention a short time ago, that the class of *Coterelli* had its origin in two sources — the slaves and the landless freemen. The slaves, therefore, of the eleventh century were certainly one source of the cottagers of the thirteenth century; and so, in all probability, were a part at least of the classes intermediate between the slaves and the *Villani* — that is, the *Bordarii* of Domesday Book and the

Cotsetel and *Geburs* of the *Rectitudines.* Let us proceed to examine these three classes.

The essential features of the *Kotsetlan-riht*, according to the *Rectitudines*, are the following: the *Cotsetel* is explicitly spoken of as a freeman, but as not paying a land tax, like the *Geneat* or *Villanus;* his holding is generally five acres, and his regular obligations are one day's labor a week. His free status associates him with the *Villanus*, but his obligations — labor instead of money or produce — appear to show that his tenure is not one of prescription, like that of the full member of the community, but is at the lord's will. These features all point to this class as that of which we are in search — freemen who have lost their hold upon the land, and who have received from their lords small and precarious grants. The obligation to labor one day in the week seems to have been a very common one in England. In analyzing some years ago the tenants of some English manors at the period of the *Extenta Manerii*, I found a class intermediate between the *Custumarii* and the *Coterelli*, which it was difficult to attach positively to either of these classes. These are the *Lundinarii* or "Mondaysmen," who had holdings ranging from two to six acres, and labored one day a week throughout the year. I pointed out this feature which they had in common with the *Cotsetel*, but did not attempt at the time to pursue the subject further.

The *Geburs* are described, in the same document, in terms, which show that they were not a free class, and were in a rather harsh condition of serfdom. Their ordinary obligation was two days a week (besides numerous occasional services), their holdings averaged larger than those of the *cotsetel*, and they received stock and seed; but at their death everything they had was the property of the lord. This last is the clearest mark of serfdom, and is called *mainmorte.*

We pass now to Domesday Book. The names of both the classes above described are found in Domesday Book, but in very small number; there are enumerated in all England 1749 *coscets* (all in the west of England), 5,054 *cotarii*, mostly in the south, a few *cotmanni* and 64 *Geburs*, also in the south. Of course it is impossible that this handful should represent the cottagers as a

class. The class of cottagers are the *bordarii*, 82,119 in number, distributed in due proportion in every part of England, and constantly associated with the *villani*, 108,407 in number. Here we have evidently the customary tenants and the cottagers. Unfortunately Domesday Book rarely gives any information as to the obligations of the several classes. We have however, a few items of information. In the first place the *bordarii* are regularly associated with the *villani*,[1] from which it appears that they occupied the village and not the lord's demesne. In one case their labor is put at one day in the week.[2] And although as a rule, the holdings are not given, yet in several manors of the county of Middlesex they are given in detail; and here we find the *bordarii* holding five and six acres apiece; also holdings in common — 6 *bordarii* of 30 acres, 16 of 2 hides (acres not given), 36 of 3 hides, 4 of 40 acres, and 8 of 1 virgate (or one-fourth of a hide). From these data it follows with certainty that the *bordarii* were an outgrowth of the village community; that they were originally villagers like the *villani*. They would appear also to have held their lands by prescription and not at will; but this is not a positive inference, and on other accounts seems hardly probable.

With regard to the *cotarii*, we learn just about as much as with regard to the *bordarii*. We find these too associated with the *villani*,[3] and find them holding four and five acres apiece, or mere gardens for a shilling each,[4] or, in common, 3 with 9 acres, 2 with 4 acres, 22 with half a hide, and 46 with a whole hide. These facts prove that the *cotarii* likewise were an outgrowth of the village community, and belonged properly to the class of *villani*. But the *cotarii* and *coscetí* are so few in number and so scattered, that we can infer very little in regard to them.

---

[1] Vol. I, f 4. a; Leminges in Kent; centum et unus villanus cum xvi bordariis habentes lv carucas. f. 284 c; Colingeham in Nottinghamshire; vii villani et xx bordarii habentes xiv carucas. f. 350. Tatenai in Lincolnshire; v villani et ii bordarii arantes v bobus.

[2] Vol. I, f. 186. Ewies in Herefordshire. xii bordarii operantes uno die ebdomeda.

[3] Vol. I, f. 9. a. Wichehame in Kent. xxxvi villani cum xxxii cotariis habent ix carucas.

[4] Vol. I, f. 128. Westminster in Middlesex.

The name *bordarius*, used in this document and in a few other occasional cases, may assist us to a conclusion. It is a French term, used by the French officials of William the Conqueror instead of the native English term. In France, the *bordarius* was the tenant of a *bordaria*, a smaller estate attached to a *mansus* or hide, upon the outskirts of which it was situated[1]; the *bordarius*, therefore, although not a full member of the community, was an outgrowth of the community and belonged, by origin, to the class of *villani*. He was a cottager, but a cottager of free origin.

The French *bordarius*, therefore, the occupant of a cottage upon the estate of another peasant, belonged by his origin to the class of *villani*, but did not hold his land by prescriptive right, like the *villani* proper, but by special grant, like the serfs. He was a cottager, but a cottager of free, not servile, origin. It does not follow, of course, that the compilers of Domesday Book used the term strictly in this sense. In all probability it meant to them simply *cottager*, and they applied it without discrimination to all those English peasants whom this term could properly describe. It is not surprising that they classed together, under this name, the *cotsetel* or free cottagers, and the *geburs* or serfs, seeing that these classes agreed in occupying cottages with a few acres attached. It must be remembered that Domesday Book does not, as a rule, record *tenures* but classes of men. It was no object to distinguish between the different classes of cottagers, whether as to tenure or as to status. And if in a few instances we have *cotarii* or *cosceti* by the side of *bordarii*, all we are entitled to infer is that the officials who drew up the report of this particular manor, noted distinctions which other officials passed over as insignificant; that the distinctions existed generally, but were not generally put on record. It was not even necessary that the *bordarius* should hold any land at all. Domesday Book mentions one *bordarius* who, on account of poverty, had nothing,[2] and ten who had no land of their own.

---

[1] Lamprecht; Beiträge zur Geschichte des französischen Wirthschaftslebens, p. 88.

[2] Vol. I. f. 177 b., Hatete in Worcestershire. Vol. II, f. 290, Gepeswiz in Suffolk.

We are therefore entitled to conclude that under the French name *bordarius*, Domesday Book includes the two Anglo-Saxon classes of *cotsetel* and *geburs*, two classes which were both, probably, of free origin, but one of which had sunk into genuine serfdom, while the other might still be described as free peasantry. Two hundred years later, the class of cottagers included also the now emancipated slaves, all being equally serfs in status, and equally lacking any interest in the land, beyond that of a tenure at will.

But the cottagers of free and of servile origin, although agreeing in status and in tenure, were nevertheless not wholly identical. They appear to have differed in the locality of their residence and tenure. It has been already said that the cottagers of free origin in the eleventh century, so far as can be traced, being sprung from the class of villagers, had their residence in the village[1] among the tenants of higher class. This is certainly the case with the French *bordarii*, and it may be inferred to have been the case in England. But the slaves, being the personal property of their lord, had their residence, not in the village, on the tenement lands or *utland* of the manor, but on the lord's personal estate, the demesne or *inland;* just as, on our southern plantations, the negro quarters were in the neighborhood of the "big house." When the slaves were emancipated, it was natural that they should continue to live upon the demesne, occupying cottages and petty holdings just as the older class of cottagers did upon the tenement lands.[2] Or if new lands were cleared upon the waste, they might receive patches of this. At any rate they would not be in the village with the customary tenants and their companions.

This probability is converted into a certainty by a few isolated facts which we meet with in the period between Domesday Book and the *Extenta Manerii*. The rent-rolls of the end of the 13th century, the period of the *Extenta Manerii*, class all the cottagers

---

[1] See, for the residence of cottagers in the villages of Germany, von Maurer. *Geschichte der Fronhöfe*, Vol. III, p. 198.

[2] Von Maurer, id. p. 311, speaks of *coloni* upon the *Hofländereien* (or demesnes.)

together. The status and the tenures had now reached their fully developed form. But in the earlier rent-rolls we find these classes clearly distinguished. Thus the Abingdon Cartulary,[1] after enumerating the free-holders and customary tenants of the manor, adds (manor of Boxole): *in eodem hamel sunt* xv *cotsetl' ad opus*, etc.; and then goes on: *Hi extracti sunt a dominio*, giving the names of twenty-six petty tenants. A few years later (1222) is the Domesday of St. Paul's, edited with learning and judgment by Archdeacon Hale. This contains the rent-rolls of twenty-two manors; and in nearly every case the roll begins with *Isti tenent de dominico*, to which follows a list of petty holdings upon the demesne; then come the free-holders and other tenants. *Cotarii*, when there are any, are put after the free-holders and customary tenants, that is, upon the tenement lands. I cannot find any direct evidence to support the view, in itself shown to be probable, that these tenants in the demesne were the descendants of slaves. It is noticeable, however, that the handicraftsmen are generally found here;[2] and upon the continent it is an established fact that the handicraftsmen were of unfree origin; whether it was so as a rule in England or not, I cannot say.

The same document enables us to make a comparison between the tenants of the same manor at two different periods which, so far as it goes, confirms the view here taken. It must be observed that the period between Domesday Book (1086) and the Domesday of St. Paul's (1222) was full of convulsions, social as well as political. During this time the class of free holders came into existence, and the class of slaves went out of existence. It is difficult, therefore, to trace any clear connection between the classes of the peasantry in the two documents. The following will serve as examples. The manor of Sandun in Middlesex had, according to Domesday Book,[3] 24 *villari*, 12 *bordarii*, 16 *cotarii*, and

---

[1] Vol. II, p. 301.

[2] Thus, in the manor of Beauchamp, p. 33, I find *textor* (tailor), *pellipartus* (tanner) *faber* (smith) *carpentarius* (carpenter) and *pictor* (painter). So in the manor of Boxole, given above, there were a tanner and a miller upon the demesne.

[3] Vol. i. f. 136.

11 *servi.* In 1222 there are 24 *operarii* (corresponding exactly to the 24 *villani*), only 8 *cotarii*, 23 *libere tenentes*, and 24 tenants of the demesne, a considerable number of whom are also reckoned in the other classes. This would appear to show that the freeholders originated in cottagers as well as in *villani.*

In the little manor of Norton, in Essex,[1] there were only two *bordarii;* in 1222 there were six tenants holding from five to ten acres apiece. Here it would appear that the *bordarii* were petty tenants with no special rank.

The conclusion which we seem entitled to draw, is that the *Cotsetel* of the *Rectitudines*, lumped together with other cottagers in Domesday book, were nevertheless a quite permanent class, reappearing in feudal times, under the name of *Lundinarii*, or "Monday's men," as a kind of aristocracy among the cottagers; that the *Geburs* were, like the *cotsetel*, of free origin, but lower in condition, and that they were the principal source of the cottagers upon the tenement lands; while the cottagers of the demesne and the cleared lands were in great part the descendants of the slaves of the eleventh century.

---

[1] Vol. ii. f. 12.

THE PHILOSOPHY OF HISTORY.

By Prof. A. O. Wright.

Within the last century the study of history has taken a new departure. The materials of history have been sifted more carefully, and researches have been made in every direction for new material. The monuments of Egypt, of Assyria, and of Babylonia have been made to give up the dead languages buried in them, and to tell the tale of their forgotten dynasties. The ancient language and civilization of Hindoostan reaches across the eastern continent to claim kinship with the sons of Japhet in the West. Historical and antiquarian societies have sprung up all over Europe and America to gather every document and every monument that can furnish material or illustration for history.

Historians are beginning to pay more attention too, to the grand forces that move society. History is ceasing to be the annals of monarchs and the story of battles and is coming to be more and more the record of the collective life of a nation or of the whole human race. The scope of history is thus greatly widened.

And, thirdly, there is coming into existence a philosophy of history which attempts to explain the causes of the greater movements of mankind. Thus in a history of any nation or epoch we may reasonably ask for three things, accuracy of detail, breadth of view, and a presentation of causes and effects, or the philosophic relation of facts. It is with the last that this paper will attempt to deal.

There are three great conditions of history. Each of these is claimed by one school of historians to be the chief or only cause of human history. And according as we lay stress on one or another of these great conditions will our whole interpretation of history vary from materialism to idealism.

The first great condition of history is found in the physical characteristics of the earth. Of these the most important is climate; but all the physical conditions that affect commerce agri-

culture or manufactures should be grouped together here. The chief of these are climate, fertility of soil, access to the sea or navigable waters, level or mountainous surface, and workable veins of metallic ores. There is a school of historians who insist that these physical conditions explain all or nearly all the great movements of history. And one historian of this school has gone so far as to make climate the sole cause of our civil war, and to prophesy therefore that as north and south have different climates they must always be hostile, and to predict a succession of wars between them.

The physical conditions of the earth will doubtless explain much of its history. The first civilizations of the earth sprang up in the semi-tropical alluvial valleys of the Nile and the Euphrates, where the conditions of life are so easy that a dense population can be supported. The sea coasts have been favorable to enterprise, and the mountains to freedom. The tropic and the frigid zones have nourished indolent savages; the temperate zones have been the abode of civilized man. Iron or bronze have been the necessities, and gold and silver the luxuries, that mark the beginning of civilization. Had England remained connected with the continent in historic as in geologic ages, Henry VIII and Charles I could have become despots, and Napoleon could have conquered her. Climate and soil made cotton king, and slavery profitable enough to be worth fighting for.

But the physical conditions of the earth will not explain everything. The valleys of the Euphrates and the Tigris were once the seat of empire, why are they so no longer? The same sun shines on the same soil, watered by the same rivers; the physical conditions are the same as when Babylon, or Nineveh or Bagdad stood in splendor; but other causes are weighing on that fair land. The creed of Mohammed and the greed of the Turk are stronger to destroy than climate and soil are to build up. England and Japan are strangely alike in their physical conditions, but while England has lived a thousand years of healthful progress, Japan lay in the sleep of feudalism, till awakened by American cannon. Other causes must be sought for the growth and decay of nations besides their geography.

The second great condition of history is found in the division of mankind into races, with their various characteristics. Here again, a school of historians is found to claim the characteristics of race as the main-spring of history. The laws of heredity and of the survival of the fittest in the struggle for life can be applied to the history of mankind as well as to the history of birds and beasts. But in the one case as in the other there is danger in trying to make these laws explain everything. The origin of our free institutions to-day can be traced in the stubborn hardihood and love of personal freedom of the German stock from which we have sprung. The same steady bravery of the Teutonic stock which won the day at Gettysburg and at Saratoga, changed the history of Europe also at Waterloo, at the siege of Leyden, at Morgarten and at Lutzen. The same love of local freedom, which created the United States of America, created also the kindred Federation of Switzerland and the United States of the Netherlands. But why have a part of the same race in Germany for a thousand years submitted to petty local despotisms, from which they have but just emerged? Why did the Arabs sleep in their peninsu'a till Mohammed came; and what has since become of the old Norse love of daring adventure? What is the secret of the marvellous change now going on in Japan? These are questions which history indeed can answer, but not a history based on race alone. The law of heredity can best explain the temperaments, features and dispositions of mankind. Leading traits of character will be preserved by nations through every vicissitude of fortune and every change of faith or clime. The Gaul of Cæsar is the Frenchman of to day in disposition, but not in institutions, language or religion. His leading traits have survived the influence of imperial and of papal Rome and of the German conquest. The Turk on the throne is still the Tartar of the steppes in spite of the Koran on the one hand, and of Europe on the other. Three thousand years have not sufficed to change the physical or the moral traits of the Greek, the Hindoo or the Negro. The law of race has its limits; but within these it is powerful.

The third great condition or cause of history is found in ideas. Man is distinguished from all other forms of life on this globe by

his ability to grasp and to carry out an idea. The ideas which have ruled man may be grouped in four classes.

The most important ideas and the ones which have had most effect on history, belong to the first class, that of religious ideas. The history of modern Europe would not have been written at all had it not been for christianity, which recreated civilization. The great Protestant movement of the sixteenth century has given birth to Anglo Saxon freedom on both sides the Atlantic, and has built up a new German Empire on the ruins of the old. And the events of the past year are opening our eyes to the evil influence of the faith of Islam upon the destinies of the Orient.

The second class of ideas are the ideas of government. Until of late the history of the world was the history of its governments. Monarchy, aristocracy and democracy have all had their champions and their martyrs. The divine right of kings, the divine right of nobles and the divine right of majorities to rule, have each, at times, controlled the destiny of nations, and have been only less powerful than religious ideas in making history.

The third class of ideas are those concerning the family; whether it shall be composed of one man and one woman, with their children, or of one man and several women and their children, or of one woman with several men and their children; whether the union shall be for life, or at the pleasure of one or of both parties to the marriage contract; what shall be the position of the wife in the household, as a slave or an equal; what shall be the rule of inheritance for the children; what shall be the education of the sons, to the father's business or to whatever business they are fitted for; and the conceived analogies to the family found in the clan or in the nation. The history of China or of Turkey cannot be written without understanding the Chinese or the Turkish idea of the family. No one can rightly understand the complete social and political change in France since the revolution without studying the effect of the Napoleonic law of inheritance.

The fourth class are social causes, such as the tenure of land, the condition of the laboring classes, the state of general education and of the higher education and the opportunities for rising in life. No history of the Roman republic can explain its speedy

decay without telling of the grasping land monopoly of the senatorial ring, and the consequent change of the Italian peasantry from free farmers to slaves. No history of the new Germany of Stein and Bismark could fail to tell of Prussian schools. And the whole history of our own country for the last half century turns upon the conflict of two systems of labor and two theories of education.

There are thus three great sets of causes which govern history: geographical causes, ethnological causes, and ideal causes. In an individual man we should call these outward circumstances, hereditary character and purposes of life. If we know these three things about a man, we know what that man is; and so with a nation, if we know the outward circumstances in which it is placed, if we know what sort of hereditary character it has, and if we know its leading ideas we know its history. Most historians err either by neglecting these underlying causes of history entirely, or by attaching far too great importance to some one of them at the expense of the others. In all ages of the world each of these causes has had some effect upon history. In the earlier ages and in all times among uncivilized tribes, geographical causes have had much greater power than among civilized nations to-day. Undoubtedly the differences of climate and locality worked far more rapidly in the first ages of the world, when men first divided the earth between them, than they do now. The whole history of barbarism is a history of adjustment to conditions of nature and the whole history of civilization is a history of triumph over nature. Obstacles which were insuperable even a century ago, are now easily overcome. To the barbarians of the Homeric song, a petty expedition against a small Asiatic city involved more difficulties and consumed as much time as it required of the later Greeks to conquer the whole Orient.

And as civilization is overcoming geographical difficulties by intellectual power, so also it is overcoming hereditary difficulties by moral power. The progress of civilization has been two-fold, in a material progress of subduing nature, and in a moral progress of subduing man. The history of government and of religion is the history of a constant triumph of ideal forces over

inherited barbarism, and the gradual growth of a hereditary civilization.

Thus if we are to study the laws of history rightly, we shall allow a greater relative power to geographical and to ethnological causes in the earlier ages than in the later, and among barbarian than among civilized men. For instance, the time was when civilization was limited to navigable waters, because commerce was thus limited. And the teaching of Ritter that the proportionate extent of coast line on the several continents determines the amount of their civilization is true as far as it goes. But now commerce no longer depends on coast lines, but boldly explores the interior of great continents with its arms of iron, and civilization at once finds a home in Wisconsin as congenial as in the British Isles. The power of thought has conquered the resistance of nature, and ideas have reconstructed geography. Again, in the early ages of the world the first great nations were found in a subtropical climate under the isothermal of 70°. As men gained in skill in resisting the influences of cold on themselves and their works, the yet greater nations of classical antiquity grew up under the isothermal of 60°. And now the mental, and therefore the material power of the world, is found at about the isothermal of 50°.

Or take the rude barbarians over whom Alfred ruled, or the pagan savages, their ancestors of a few generations before, and contrast them with the Englishmen and Americans of to-day, and see what the combined forces of Christian faith, constitutional government, and scholarly learning have wrought, and see how the whole course of our history has been changed and ennobled by these ideas.

The ideal force in man is a greatly varying force and is capable of almost infinite growth, while the forces of climate and of race are nearly constant forces. While these are relatively more important factors of history at first, the force of ideas is a growing force which comes to be in modern history by far the most important. The student of history will err if he regards these forces as having a constant ratio to one another, and neglects to note the growing power of ideas.

It would be a fascinating subject of inquiry to ask what are the relations to one another of the ideas that have ruled the world, and the relative importance of each; but the limits of this essay forbid me to enter on that subject.

The three great conditions or causes of history, which we have thus far considered, are constant causes always at work. The influence of any one of them may be more or less in different ages or countries, but it is always something. There are other causes in history, which are occasional and temporary in their character, but which sometimes have great weight, and turn the course of history to a certain extent. But because they are occasional and transitory their effects are far less than these constant forces of which we have spoken.

There is, first, the influence of nations on one another. Mankind in past ages have been uniformly so selfish and narrow and cruel, as to think that one nation can only be happy and prosperous at the expense of other nations. The arts of war have had the honor and the service which rightfully belongs to the arts of peace. The history of the relations of nations has been a record of war, of conquest and of oppression. And, therefore, the decisive battles of the world are of interest to the student of history. Sometimes their results were a foregone conclusion, as when the training of Prussia in school and camp was matched with the ignorance of Austria on the field of Sadowa, or when Philip planned and Alexander carried out the first united effort of Greeks to conquer the effete Persian despotism. Sometimes they are decided by that class of providences which men call chance, as when the fire at Moscow broke the power of Napoleon, or the storm shattered the pride of the Armada. And not only the decisive contests, but the indecisive ones also have had great and varied effects upon the course of history. Of the Thirty Years' War, it is not enough to say that it resulted in a drawn battle between Protestantism and Catholicism; history must note also that it put back the progress of Germany two centuries, and made her for that time a mere "geographical expression."

The Crusades directly accomplished nothing; but indirectly

they made barbarian Christendom acquainted with the civilization of Islam, and gave life to the germs of modern freedom in the free cities of Europe. And the wearisome and seemingly senseless wars of modern Europe to preserve "the balance of power," have helped to nourish that competition of nations in the arts of peace as well as war, which forms our best guarantee for a constant progress of civilization.

The influence of great men, too, should not be forgotten. That influence is often overrated. Of the heroes of history, many are sham heroes, followers, not leaders, who have made a great noise in the world, but have not perceptibly changed the course of history; and every great man must be in great degree the representative of his age, and know how to follow in order that he may lead. Yet, after every allowance has been made, there are certain great men, who have led their times and who have really made history. Such men as Cromwell, Richelieu, Pitt, Napoleon, Bismark, have made the history of modern Europe read in quite a different way, from that in which it would have read had they not helped to make it.

But above all these second causes, stands the first great cause of all history. If we believe that there is a God, we must believe that he has a plan in his government of the world. And if we believe this, history to us ceases to be the result of the conflict of blind physical forces, or the record of trials of strength between contending ideas. A regular purpose is seen to run through the providences of history. Some great idea is being unfolded in scene after scene of the great drama we are playing God's redemptive government of the world, is seen in the political sphere in the progress of liberty; in the social sphere in the progress of civilization; in the scientific sphere in the progress of knowledge, and in the religious sphere in the progress of christianity.

To understand history then we must recognize the reign of law there — physical laws, that set the limit of climate and soil and commerce, and thus limit the habits of man, and so modify his character — physiological laws that keep up race peculiarities and thus produce and limit habits and through habits character — psychological laws that raise man above the level of the brute by

his teachability, and by his ability to conceive and to carry out far-reaching purposes, and finally the influence of a higher power upon the whole race. History is not a fortuitous sequence of events. It is subject to law, and is the working out of a plan in the Divine mind.

Says Bunsen, "To write the history of a nation is to recompose a canto in that great epic or dramatic poem, of which God is the poet, man the hero, and the historian the prophetical interpreter."

LIFE INSURANCE, SAVINGS BANKS, AND THE INDUSTRIAL SITUATION.

By C. CAVERNO, Lombard, Ill.

Having occasion recently to borrow five hundred dollars, I applied for a loan to one of our successful life insurance companies, which has amassed assets amounting to many millions of dollars. I was informed that, whatever the security I might offer, the rules of the company forbade a loan for so small a sum.

Now that the regulation of the company was not wise, for its own convenience and protection, and for the interest of all those, myself included, for whom it was acting as trustee, I do not for a moment maintain. But this transaction represents a state of affairs to which I should like to call attention. We may find by investigation upon it some clue to the monetary stringency of the times — possibly some explanation of the malign aspect of the labor horizon.

In common with, say, forty thousand other men, I had been paying to this company small sums of money for a long series of years. Yet when I, or any one of my forty thousand fellow policy holders, wanted a loan for less than a thousand dollars, no matter what evidence we might give of financial soundness to the extent of the money desired, we must look elsewhere for it.

The funds of this company, as of all other companies, are largely made up from the contributions of the poorer class of young men — young men who are struggling for a competence, and who have taken out one or a few thousand dollars of life insurance, to secure creditors of whom they have borrowed small sums, or to tide a wife and children over the shoal of poverty in the event of death.

Now whatever the intent of life insurance may be, and however excellently it may serve certain purposes, yet here is a state of facts inviting reflection not only from the large army of policy holders in the United States, but from any one who will try to

ravel intelligently the complications of our industrial condition. The men of humbler means, in putting their little savings into life insurance, have been aggregating vast sums with which large capitalists might operate, but from which they themselves could not get a cent for their lesser and, we shall maintain, equally safe enterprises.

The capitalists not having legitimate enterprises in which to put the larger sums which the insurance companies have placed at their control, have become speculators, have lost their ventures, and swamped the insurance companies loaded with bogus, insufficient or depreciated securities; and the insured and his money and insurance have been forever parted.

The working masses must reflect that the plethoric millions, which they boast of as constituting the assets of their favorite company, are so much money collected from themselves and put beyond the possibility of their own manipulation. More than a billion of dollars within a generation have been gathered from all quarters of the country; from all pursuits and occupations; from farm and country village, and massed for use in the large cities.

If this enormous aggregate were distributed to, or could be handled by, the people from whom it came, financial relief would at once be widely felt. The wheels of the humbler enterprises would be speedily oiled. When it becomes possible for *them* to secure accommodations, we shall start anew in industrial prosperity, and out of the sum of small movements we shall reach the possibility of great ones without peril.

It is in industry as in nature — you cannot have rivers without rills.

The facts are the same with reference to savings banks. They may serve the poorer classes well in some respects, but in others, and they are important ones too, they are an injury. They may help each individual to save his own, but they hinder each individual from being helped with the little surpluses of his neighbor. It is easy enough to deposit five dollars in a savings bank, but no poor man can get an accommodation of five dollars *from* a savings bank.

The man who loans the bank a small sum is welcomed. The man who wants to hire a small sum is recommended to the pawn broker.

The aggregate sum in a savings bank is just so much money removed from the possibility of use among the poor and handed over to the rich to help them widen the distance already separating the poor and the rich. It is so much contribution to speculation under whose influence the value of wages is uniformly depressed as against the commodities the laborer needs to buy.

It is easy enough to see the road over which the savings banks have gone to the wide-spread ruin which is their recent history.

Many littles have made much; and the bank officers have found themselves in position to enter into operations to which wild times and greedy ambition invite.

Before any war of labor against capital, there has been a war of capital against capital — capital bidding against itself for the supposed profits of great enterprises.

If the best of these great enterprises could not be secured the next best must be and so on. The best has proved to be none too good, and the rest it is useless to try to characterize.

The poor in putting their surpluses into savings banks, have simply been standing idly by while capital has been employing their earnings in this interesting game of outwitting itself and them.

A savings bank for the poor is a great "How not to do it."

Men of small means need accommodations as well as those engaged in larger enterprises.

If an institution is for the benefit of the poorer classes, they ought to have a chance to get something out of it as well as to put something into it. This want a savings bank, if managed with ever so good intent, cannot in practice meet.

A radical fault in the savings bank system is that it is an attempt to relieve the poor from the necessity of taking care of their own funds — from the exercise of their own brains upon their own finances. The system promises to take care of the poor when they should be taught to take care of themselves. It prevents the poor from using what the naturalist would call the providential instinct.

The good savings banks accomplish is very much over estimated.

The statistics of amounts deposited are often taken as an exhibit of savings which would not otherwise be made.

The probability is that almost all that ever appears on the books of a savings bank would have existed as savings, only it would be loaned out in such ways that no statistician could reach it.

A thing that will astonish you, as you become acquainted with the depositors in a broken savings bank, is not the number of imbeciles that have been ruined, but the number of intelligent, capable, saving people that have been duped. Some of us can remember a generation of factory-girls who made close savings when no savings banks were within their reach.

The first spare money that came into the New Hampshire town in which I was raised, was the savings of our factory-girls. Almost every home took on a new appearance from the surpluses sent back by the girls at work in the factory. When fathers and mothers got in a pinch for money to keep a boy or girl at school, the first resort was to the savings of the factory-girls.

These young women were their own bankers. They did not ask any favors of savings banks. They found out to whom it was safe to loan and to whom it was not. They knew whether a man who sought to borrow their earnings had a mortgage on his farm or a chattel mortgage on his stock, and, if so, for how much and to whom. Some of these women remaining single and managing their own funds came to possess the large fortunes of their locality.

Now what a savings bank would have done for these factory girls would simply have been to make them babes in finance instead of self-sufficing bankers.

It would have led them to surrender to others an intellectual exercise in the highest degree profitable to themselves. Their earnings would have gone into a vast aggregate to be swallowed up by a kite-flying banker in the "down east" speculation which did ruin so many venturesome capitalists; and the clap boards and shingles would have rattled in the wind on the old houses which

were spruced up, by their thrift, with white paint and green blinds.

If savings banks teach people to save (which is very doubtful), they still are an evil in that they paralyze the very faculty we most need to cultivate, and that is *the ability to manage savings.*

When representatives from half the families of a great city abandon the use of their own intellect by delegating to others (and these others, all told, numbering no more than a score) prob'ems they themselves ought to solve, they ought not to be greatly surprised if the end of the transaction is catastrophe.

There are *moral* evils which demand consideration. The moral element plays an important part in finance. And by moral or morals in this discussion I refer to general intent, purpose, quality of life.

We substantially tell the poor by the savings bank system that they need take no care, on the score of morals, relative to their finances. The bank stands as a moral insurance company and takes the risk in that department. We say the difficulty of the times is want of confidence. But that want of confidence arises fully as much from fear of the moral meaning of men as from distrust of their intellectual ability or executive energy.

Whom to trust is the great question, and the ictus of it falls on the moral realm. But morality is strictly an individual matter. You cannot create a moral corporation.

Yet respectably intelligent people, by tens of thousands, have acted as though they supposed this had been done. They have gone like birds to the snare of the fowler to put their earnings in a savings bank, unsuspecting and without inquisition as to the morals of the men who were to handle their funds. A bank was a bank, and a bank was safe — a savings bank was safety itself come down to dwell among men, incarnated and apotheosized.

When you come to consider the question of safety it will be found that you cannot solve that matter until you have resolved moral elements. There the basis of safety will be found to rest in the good sense and honesty of the individual man — a man who can explain himself and his whole financial situation to the lender of money.

If banks are safe, it is because they are officered by such men. It is better to put on each individual the burden of finding out this honest man, in order to deal with him, than it is to delegate the search.

There are no safer sums than the majority of small loans; such as are made from man to man in the processes of small enterprises.

The moral element comes to the front in such cases. There is an element of personal faith in them worth more than any mere pride of financial honor that rules on 'change — more secure, *pro tanto* than the property values of the greater capitalists.

When men have been trained to find an honest and capable individual, they may be expected to be able to find corporations of similar character, if there is advantage in dealing with corporations. But to create corporations with an implied understanding that by them the poor are to be relieved from the exercise of moral providence, is an ethical blunder on its face, and we might have expected from it just what the history of savings banks in this country shows, failure distinguished, conspicuous.

But there is a moral fault lying behind the one discussed. Now that we have had so many disasters with savings banks, every body has fallen to work to devise some double-sure, iron-clad, adamant-bolted system of safety for the poorer classes.

We might pause on our way to ask who the poor are for whom we are to make such certain provision.

Where is the dividing line between the poor and the rich? Perhaps it is where the insurance companies draw it so that a man who cannot swell his wants to upwards of a thousand dollars, shall be regarded "*hors de combat financier.*"

We in Illinois have passed a statute that no savings bank shall receive on deposit more than four thousand dollars from one individual.

Society then to compensate a man for his inability to borrow, will step in and insure the safety of his loans to these amounts.

Why is it not the business of society to help a poor man borrow as well as to help him to lend?

But the moral question comes up: is the selfishness of the poor to be insured?

We are pretty careful to teach the rich that they are to regard themselves as stewards, and sometimes to take a little risk to help struggling worth upon its feet.

How far down the scale shall we come in pressing this duty? If a man has five thousand dollars to loan shall he have the moral responsibility of helpfulness loaded on him, while he who has five dollars only to lend shall think only of his own safety?

The truth is, the poor can help the poor as well as the rich, or the rich the poor, and they ought so to help one another.

The men of humble means ought not to be relieved from the responsibility of helping their fellows in the struggle for existence as they have opportunity.

The poor are on the war path against capital. What have they done with their own little surpluses? The chances are that in the scramble for safety they have shut their hands and their hearts against some humble enterprise, which might have been saved from ruin, in order that their little sums might further inflate the balloon of some rascal who ostentatiously paraded himself as a great capitalist.

We are wondering when "easy times" are to come again. They ought not and probably will not recur till "judgment begins at the house of God;" till the poor begin to be willing to help the poor; till they cease to regard safety to themselves as the ultimate good; till they are inspired to help others as well as to protect themselves.

When the poor have canonized selfishness by looking only for the safety of their own means, is it any wonder that a selfishness of broader grasp has confiscated all they have put in its possession? The game has been, "keep what you have and catch what you can," and at that the dozen directors have beaten the forty thousand depositors.

Life insurance takes its place in the savings bank system, and in the same way in respect to it the people have gone crazy.

The legitimacy of life insurance, under certain exigencies, and within certain rational limits, I should not wish to deny. I should even want to assert it. But the claim has been made that life insurance was the best form in which men could lay up property;

and thousands and tens of thousands of our young men, abdicating their own financial skill, have been cramping themselves and rendering themselves useless to everybody and everything in their own day and vicinity by carrying large policies on their lives. The aggregated premiums have constituted vast sums for which the directors of the company could not or would not find safe investment, and so we have had the recent history of insurance, and the end is not yet.

There is absurdity on the face of the matter that the directors of an insurance company can make and keep fortunes for forty or fifty thousand families. Propitious circumstances in singular instances may accomplish prodigies in this direction. But if that style of fortune making can be long and widely carried on with success, then most men *were* made in vain; man is a botch, and it is idle to reason about him or his affairs.

Well, this system of delegating to others what intellectually and morally pertains to ourselves, having failed on the old plans, the air is full of new schems. The only one which we can notice is the one which puts the national government into the breach.

The secretary of the treasury proposes a subdivision of the interest-bearing national debt minutely enough to put it into the power of the poor to utilize it as a savings bank system. That, for its own purposes, the government did not long ago do this is a wonder. But for the poor it is simply a proposition to tie the times up tighter; to take another twist on the screw of constriction under which the poorer classes already groan.

The result will be to collect all the little rills and send them just where all the greater streams have gone, to swell the vast amounts locked up in U. S. bonds, insurance assets, securities and stocks of all sorts — amounts removed partially or entirely from participation in the living enterprises by which society is supported and out of which wages are paid. It may be best under our present circumstances to adopt the plan. But let us clearly understand that the policy is a make-shift any way. Suppose, as all honest men mean it shall, the government sets the high example of paying its debts, what will become of this system of savings banks? Must the government keep in debt in order to main-

tain it? Then again, the very last thing we want to do is to add to the force of the feeling among the poor that the government is to take care of them. Even a government system of savings banks, in the long run, will be no kindness to the poor.

We are drifting all too rapidly to the notion that the government is to take care of us all. Here is even a religious newspaper of some note, advocating the idea that since we have lost faith in men because of bankruptcies and failures, we must now put the nation where before private enterprise stood. The poor, this journal says, will trust the nation as employer and paymaster.

Has not all this been tried over and over again to the overthrow of the nation that tried it—its rich and poor together? Rome stood in the gap and found corn for its people till the Goth came and "destroyed them all;" and that just because he was up to the problem of providing for himself and the Romans were not. "Lost faith in men?" why we have not put faith in men; that is just the thing we have been tryiug to avoid. We have been seeking safety on a property basis only, and have made no account of faith in men; and the men whom we have entrusted with our funds have known it, and have exhibited the same heedlessness respecting moral considerations we ourselves have shown.

We have lost our wits as to where the problem of industrial reconstruction is to begin. We are looking for it to begin at the top instead of the bottom; looking for it to begin where we left off, instead of starting anew.

We *were* looking for wars in foreign lands to create a demand for our products. Thank God, the European war last past proved that resource a broken staff!

We are looking for an era of railroad making to spring up again. But that era will not come again, as a private enterprise, till we have earned, from bottom dollar to top, the money to put into such kind of expenditure.

We are looking for the government to start a great system of internal improvements; to build the North and South Pacific railroads; to embank the Mississippi river; to dig a ship canal around the lakes or through the heart of the country.

By engaging in such enterprises, in the present condition of things, the government would simply break its own back, and take the burden off the back of nobody.

That is not the road to easy times. We shall strike that road when every man, rich or poor, will look about him, and try to put in practice in his own neighborhood some very old and humble wisdom, "To do good and communicate forget not." Then, like Bunyan's pilgrims in the bogs of the enchanted ground, we may "make a shift to wag along."

To this line of argument the reply may be made: The division of labor and the combinations of capital resulting in our large system of industry, have made the system of small savings and their management by individuals, as well as the system of small industries, no longer practicable.

It is said that as the factory has superseded the distaff and loom of our grandmothers — the railroad, the postman, the ox cart and the horse waggon — the reaper, the cradle and the sickle — so the bank and the insurance company have put an end to the feasibility of individual manipulation of money. This will lead us to take a look over the manner of our industrial condition. It is true we have very largely superseded the individual by the corporation — the man by machinery.

But the question will recur, after all, how much we have made by the process.

Somehow in spite of our division of labor and combination of capital we are all at the stand still. There is a hitch in affairs evident enough notwithstanding all our power to mass men and money.

There is a limit to the profitableness of combination, and the question I raise is, whether we have not in a great many things, reached and gone far beyond that limit. The question I raise is, whether our way out of our present complications is not, not by crowding ahead along the lines of combination on which we have been operating, but by taking the back track and paying more attention to the individual and less to the corporation — encouraging enterprises of individual and local character rather than those which attempt to do the world's business in the gross.

If a colonel can manage a regiment so splendidly, what would he not do with a million of men? Very likely lead them like sheep to the slaughter.

If a drive wheel of so much weight and diameter would do so much work, what would a drive wheel of a thousand times its weight and diameter do? Fly to pieces.

We have been massing men in the industries till the power of our *generalship* is exhausted, and your industrial army is breaking up into Mollie Maguires and tramps.

We have made our drive wheels so large that they are flying to pieces of their own momentum.

When coal and iron mining can be carried on only a few months in a year, and then at a rate of wages that would not be very enticing to a gopher, it is evident that capital in that business has passed the limits of its own safe management.

The same thing is evident, too, when the spindles and shuttles of our factories stand idle half a year, and are only operated the rest of the time by women and children at rates of wages that can scarcely support life for the time being.

Under such circumstances the sceptre of ability profitably to manage large masses of men has passed from the hands of capital, and the sooner that fact is acknowledged and acted on the better it will be for it and for civilization.

So when every one of the savings banks of a great city goes by the board, it is useless to talk about the profitableness of gathering up small savings and massing them that they may figure in the combinations of capital. "Suum cuique" would certainly work more satisfactorily than that.

And when wrecking and scaling are the order of the day in insurance, it is about time to take notice that combination in that way has passed feasable limits.

It is a pretty tough thing after all to abolish the individual; and we are not so near it as we thought we were with our great process of combination. And all our financial and industrial distress will pay for itself, when once that fact is seen and befitting action taken.

There are possibilities in man beyond any possibilities in machinery.

Notwithstanding all the genius that has been expended on the sewing machine, hand sewing is still the most popular. The deft hand has still the advantage in the struggle for existence.

There are machines to sew and peg boots, but the men are few who will not willingly pay more to have the foot measured and a fit made by a journeyman as of old. And the journeyman who can meet this want has good prospect of daily bread — a better prospect than the man who tends a machine.

Notwithstanding the perfection to which the processes of the reaper have been brought you can find *successful* farmers who will testify that forty acres of grain are more cheaply secured with the cradle than with the reaper — consideration being had to the amount of money you must put in a reaper, its interest, and the cost of repair.

The reaper has the advantage on the larger tract. But that larger tract calls for broad generalship, and the tendency of our development must be toward its subdivision.

The Hon. Hugh McCulloch called attention the other day to the Gwynn farm in California. It has thirty-six thousand acres in wheat, which is cultivated and secured, we may say, entirely by machinery.

But the ability to manage thirty six thousand acres of wheat with whatever help from machinery, will be as rare as the success of Choate and Webster at the bar, or of Beecher in the pulpit.

Agricultural machinery has altered man's relations to the markets, not essentially to nature. It has made it possible for skillful generals to make large fortunes from farming. But since "Adam delved and Eve y-span" it has been possible for a man with the rudest implements to make a living from a few acres of ground, and, will be in spite of all machinery, till men "shall hunger no more."

This is society's answer to the tramp.

This fact casts light on the inevitable redistribution of population between city and country — on the rearrangement of industry between manufacture and trade, and agriculture; and on comparative property values.

It is true that in this light the prospects for wealth do not glitter. But we are likely for the next twenty years to talk

more of making a living and less of making a fortune, and society will be the healthier for it.

One would think that the combination of capital might secure the monopoly of the cutlery market — that it would be impossible for a man without capital to maintain himself against Sheffield and Meriden and Shelburne Falls; yet F. A. Seaver and son of Lake Mills, Jefferson County, in this state, carrying their steel and wares back and forth over land seven or fourteen miles, with next to nothing for capital, can make a living, and have a nice little margin to spare, on the single article of butcher knives. The reason is because they bring to every piece that leaves their hands an amount of personal care and skill that cannot be secured in the great establishments.

Within six months a tinner has come to the suburb of Chicago in which I reside — the last place where you would have said such an artisan could get a living — and has been more than busy every day since his arrival. Personal facileness in his art is the secret of his success.

Mass capital and lose genius in manipulation is the rule.

The civilization that depends on massing its capital and is not alert to foster native talent, sporadic in its appearance as it may be, goes to the wall.

It will take only a little more loading cloth with starch, earths, gums and dyes, on the part of the factories to make it profitable to bring the old hand looms out of the garret to make cloth once more that would go from year to year, if not from generation to generation.

Capital, in its combinations, has pushed out so far in many directions that it can sustain itself only by fraud, and fraud is an inverted pyramid.

When ninety-four per cent. by weight of silk is dye to six per cent. of fibre, it will become profitable and popular to wear hand-made cloths instead of such silks; and the process of making them will be as fashionable as worsted work, perhaps even as fashionable as painting in water-colors.

I believe the remedy of our present industrial stagnation is to be found in just the opposite direction from that we have been

pursuing. Instead of trying to make great combinations in which the care shall be loaded on a few individuals, we shall go back to our local enterprises and put in some care for them. Instead of trying to find some Rothschild — shall I say Jay Cook & Co., Duncan, Sherman & Co., Ralston, Winslow, Spencer, Tappan, some treasurer of a Fall River manufacturing company, or other of "the noble army" of huge bankrupts, innocent or malicious, whose debris, or the plentiful lack thereof, lie around us "thick as autumnal leaves that strow the brooks in Vallombrosa;" — to take care of our funds, we shall see if we really cannot trust our neighbor and help some struggling enterprise in our own village.

It is said that small enterprises are unsafe and go to the wall soonest. This is partially true and partially false — and when it is true it is not necessarily true. It will take a great many of these small failures to aggregate the amount lost in banking, insurance, by treasurers of companies and corporations, and officers of railroads.

When it comes to loss it is just as comfortable to reflect that you have tried to help some humble affair as that you have gilded the hegira of some of the great financiers.

Since the dawn of history there has been a contest to secure the definition of *political* rights. That contest is pretty much ended in civilized nations. The overthrow of slavery and serfdom demonstrates the basis on which political rights must hereafter rest. But while *political* rights are taking their final form, *industrial* rights are still in a nebulous condition. We are in the latter about at the point in the former of the secession of the plebs from the patricians.

We have yet all the weary way from Mons Sacer down, to travel.

Do you think, Mr. President, that we are seeing the beginning of the end in the labor agitation? I tell you, nay, we are only seeing the beginning of the beginning.

There will yet be a readjustment of values as radically different from any thing that now prevails as steam transit from the footman.

Take a yard of cotton cloth, if you please, and reason about it a little.

There will be no quiet in the industrial situation till the price of a yard of cotton cloth approximates to that of a bushel of corn, perhaps of a bushel of wheat; unless utterly undreamed of inventions and conditions are worked to modify the labor of its production.

Though we have given political freedom to the slave, we have not yet touched his *individual* condition.

The price of the production of cotton is still at a point which represents the absolute chattelhood of labor. That will not stand.

In the manufacture of cotton we are working on an inversion of the family relation, and that will not stand.

The condition of no great manufacturing interest will be stable that rests on the labor of women and children.

The cotton cloth finds its way to market over railways.

Last summer the transportation business was brought to a sudden halt, the operatives said, because they could not support families on their wages. Blind and foolish these operatives were; but thousands of men do not enact blind folly without the compulsion of some master grievance.

This is certain — no men are more closely worked and more closely paid than railway operatives.

The remedy against the troubles of last summer was in prominent quarters maintained to be the employment of none but unmarried men.

Now look at the condition of things revealed by a yard of cotton cloth. Here are three great departments of industry — original production, manufacture, and distribution — which are carried on, or sought to be carried on, in flat violation of the family relation or in indifference to it. Yet we are all agog with wonder to know where communism comes from. Its origin may be suspected not to be altogether due to the outcropping of original sin in the laboring man.

As if we had not degradation enough in our own labor, we are invited by some capitalists to put labor down to the level of the Chinese system.

If there is any one gauge indicating the superiority of our civilization over that of the Chinese, it is the cost of supporting

women and children. The Chinese works so cheaply because he expends next to nothing in the support of wife and child. I believe it is understood that most of the women who have accompanied our cheap Chinese laborers to this country are not in the marriage relation. That is the one main reason of the cheapness of Chinese labor.

The cost of the Chinese wife is at the rate of the simple support of the animal woman. As between the wisdom of the hoodlum and that wisdom which would solve the labor problem by remanding woman to the position she holds among the Chinese emigrants, commend us to the former; it is not so earthly, sensual and devilish.

The end of our difficulties will not be by communism as disruptive, nor by the bullet as preservative of the old order. Neither will settle anything. The one is as irrational as the other. We shall begin to build well when we discern what has gone to pieces under us. It is clear that the present condition of things has brought into derision the political economy which has paraded its columns of statistics — the tombstones of dead acts — as the gauge of human possibilities; which has taught us that there is only one principle — competition — the law of demand and supply, which presides over the regulation of labor.

That political economy sounded very well in the mouths of doctrinaires. But society is breaking up under it, capital is shriveling, and labor idle, incommunicative, sullen. We have excellent scientific authority that the will amounts to something in the modification of environment.

The statement might have been added that the extent and quality of modification depends on the intelligence and moral intent.

Given these in high degree and of pure tone and all things are possible. Given these and we shall cease to speak of labor as a commodity. It is not commodities we are talking about, "but human creatures' lives." A remarkable commodity this which requires a national army and a state constabulary and local police to keep it from appropriating all the dear earned possessions of man. The end of that wisdom is anarchy.

We have reached in practice this demonstration: You cannot found civilization, preserve capital, organize labor, carry on any of our industrial or commercial functions, simply by the guidance of the self regarding instinct.

NOTE.— The following item from "The Christian Union," I append to the foregoing essay for reasons that will be apparent on its perusal:

"INDEPENDENT LABOR.— In spite of the multiplication of machinery there is still a strong prejudice in favor of hand-made articles of all sorts, and therein lies a suggestion that may relieve much of the distress that now causes such wide-spread dissatisfaction with the existing state of things. The 'Scientific American' says:

"The chronic superabundance of the labor supply in the older countries had developed some conditions full of useful suggestions to us. Wherever we travel, there we are surprised to learn that a large proportion of the smaller articles of manufacture, with which, in some instances, the trade of the world is supplied, are made by artisans in their own houses and with the simplest appliances; and we find there also, in almost every large town or city long established, business houses whose sole business it is to receive and distribute these goods, to find markets for the handiwork of the independent workman. We know of prosperous firms in England who do a very extensive trade in this way on an investment probably of not more than $10,000. Obtaining samples of their productions from the various artisans so employed, they intrust them to their 'drummers' or 'commercial travelers,' who travel in every direction exhibiting them and soliciting orders: on receipt of an order the special workman is notified, and soon makes his appearance with his basket or bundle of goods, which are inspected and paid for according to previous agreement. The goods are then put up in the conventional packages and shipped according to order.'

"The individual workman may thus compete with the corporations, but he can only do so by producing an article which will possess some superiority over the product of machine work. If in addition to this he can avail himself of associated means of disposing of his work, he may create an independent market for his goods." C. C.

DISTRIBUTION OF PROFITS.

A NEW ARRANGEMENT OF THAT SUBJECT.

By Prof. A. O. Wright.

The following is offered as a new arrangement of the subject of distribution of profits, differing in some important particulars from the arrangement given in any work on political economy with which the writer is acquainted.

In civilized communities nearly all Production requires the union of capital and labor. The proceeds of production are then distributed in various ways between the capitalist and the laborer. In actual practice the capitalist and the laborer may or may not be the same person; but in theory we may separate the shares of capital and labor. There is still a third party concerned in production, the business manager, who stands between the capitalist and the laborer, and by his skill in superintendence increases the proceeds of the business, and thus makes himself a sharer in the proceeds.

The share which always belongs to the capitalist is called interest, when it is paid for the use of money, and rent when it is paid for the use of real estate. The rate of interest and the rate of rent vary according to fixed laws which I need not give here. The share which always belongs to labor is called wages (or in some cases salary). This also varies according to well-known laws. After deducting interest or rent, as the case may be, and wages, including the salary of the business manager, the net proceeds are the real profits of the business. In some cases instead of profits we should say losses, but this does not change the conditions of the problem. Whoever receives the profits should also bear the losses, and generally does. There are then two questions in regard to every kind of production: first, what are the profits (or losses); and second, who gets them. In solving these

questions I make the following five cases, each of which presents a different phase of the question:

CASE I.

In this case, capitalist, business manager and laborer are combined in one person. Examples of this case are farmers who own land and furnish their own labor; mechanics who own their own shops and tools and do their own work; and merchants who own their own stores and stock in trade, and keep no clerks. This case is the simplest in practice and the most difficult in theory. As one person combines the functions of capitalist, business manager and laborer, there is no distribution of the proceeds. No one pays interest or wages to himself. The question, who gets the profits, is easily answered. But the question, what are the profits, is much harder to answer, and indeed the producers who come under this class rarely attempt to answer it. They confuse together interest, wages and profits in one lump sum, and often fail to separate their personal or family expenses from the expenses of the business, or to account for the proceeds of the business which they or their families consume.

To find the true profits of such a business, not only should all business expenses be deducted from the gross proceeds, but also interest on the capital invested and wages for the labor done. The farmer, mechanic or merchant, as the case may be, owes himself as a capitalist interest on the capital invested. He also owes himself as business manager and laborer, wages for labor performed. But all products of the business consumed in his family should be added to the gross proceeds of the business, and charged to family expense account.

In this case a real business loss is frequently concealed under the profits of capital and labor. The producer thinks he has made so much out of his business, when in fact the business has made nothing, and his receipts are really less than interest and wages should be. So also a real business profit is frequently concealed under extravagant personal or family expenses.

But it does not always follow that a farmer is losing money who does not clear the interest on his land and stock, and wages

for his labor. He has the advantage, if he is free from debt, of receiving interest without the trouble and risk of lending money or renting a farm, and he has work all the year round. He can put in odd hours and days of labor for himself where he could not in working for some one else. The great advantage of small farms held in fee simple is that more work can be put on them than could be done by hired labor. This is an advantage both for the farmer and for the whole community, as the case of France since the revolution shows.

CASE II.

In this case capitalist and business manager are the same person, employing one or more laborers. This case differs from Case I only in the employment of laborers; and as a farmer's, mechanic's or merchant's business grows, it naturally runs into this case.

In this case there is no distribution between capitalist and business manager. The net profits of the business are found as in Case I, except that the labor is partly or wholly paid for, according as the proprietor himself works or not. This payment of labor thus makes wages visible as a business expense. But the proprietor's own labor, as manager or laborer or both, must be accounted for as in Case I.

The remuneration of the laborers hired is generally (a) wages. But it may be (b) a share in the gross proceeds or in the net profits, or (c) partly wages and partly a share in the proceeds or profits. As the gross proceeds are so much more easily estimated than the net profits it is found in practice usually better to give a share in the proceeds in those cases where the laborer receives a share of the results of the business. Thus on the cotton plantations in the south, since the war, the negro laborers are often given a share in the crop, a thing which they can easily understand and in which they cannot easily be cheated; whereas if they are to have a share in the net profits it would be easy to cook up the accounts so as to cheat them, and with the utmost honesty on the part of the planter it would be hard for him to make the negroes understand the accounts he kept. But the simplest and most ob-

vious way is to pay the laborer wages, reserving to the proprietor interest on the capital invested, salary as business manager, wages as far as he performs labor, and the profits, if there are any. In many kinds of business it would be hard to introduce any system of sharing the profits with the laborer. Thus in a printing office, where the workmen are constantly wandering from one office to another, or on a farm where in harvest and threshing extra men must be hired, or in a store where the amount of sales and the net profits are both matters that often must be kept secret from the public and from rivals, —in all these cases it would be hard to introduce any system of giving the laborer a share either in the proceeds or in the profits of the business. But where such a system can be introduced it has obvious advantages over the system of wages. It produces a greater interest in the business on the part of the laborer and therefore more faithful work and greater care to prevent waste. It is the usual practice in the great mercantile houses to give the best clerks a partnership, that is, a share in the profits. The hope of this is a constant incentive to the younger clerks, and the offer of a partnership prevents the best clerks from carrying their customers to rival houses or setting up in business for themselves.

CASE III.

In this case the capitalist employs the business manager and the laborer, giving them (a) wages or salary, (b) a share in the profits or (c) a combination of the two. The capitalist takes interest, and the net profits (or losses) of the business. In this case the interest is concealed by the profits, but can be easily separated.

Thus if a capitalist builds a woolen mill, and employs a superintendent and several laborers, he usually pays a salary to the first and wages to the secoud. But he may give the business manager a share in the profits, thus virtually making him a partner. Or he may make him formally a business partner, reserving the title to the mill, and rent for it, to himself. Or he may give both the superintendent and the hands a share in the profits. The usual practice on a whaling ship is for the owner to receive one-half the oil and whalebone, and for the other half to be divided among the captain and crew, in so many "lays," or shares to each.

A variety of this case is where the capitalist is a corporation, as in the case of a railway company, an insurance company, a national bank, a city newspaper or a manufacturing company. In this case interest and profits combined appear as dividend. In a large corporation there are often several business managers, each with his department of the business. Very generally the managers are also stock-holders, and receive dividends in that capacity as well as salaries as managers.

The questions raised by the subject of stock companies and their dividends, are important questions in Distribution. But they call for a separate treatment, and are omitted in this paper.

Another variety of this case is when a number of persons are associated so carry on a co-operative store. Usually the capital of each partner is quite small; but for the purpose of carrying on the co-operative store they are capitalists, even if they earn their living as laborers. They simply club together their individual savings, so as to make a mercantile association, and then employ a manager and clerks, and sell to one another and to outsiders on such terms as they choose to offer. In England these co-operative stores have been quite successful.

CASE IV.

In this case the manager carries on the business, borrowing money or goods of the capitalist or renting land or buildings of him and employing laborers. In this case the distribution is, to the capitalist interest or rent, to the laborer wages, and to the manager salary for his services and the net profits (or losses.) It should be noted that the case is very rare where the business manager can borrow money, buy goods on credit or rent land without capital of his own as a basis of confidence. On that capital he should also have interest.

The best example of this case perhaps is the system of agriculture in England. There the capitalist is the landlord, who rents land for a term of years, generally now for twenty-one years, under definite conditions in regard to crops and improvements, and for a fixed rent in money. The business manager is the farmer, who receives salary for his services, interest on the capital he invests in the shape of stock, tools, improvements on the land

and advances made to the laborers before his crops are sold, and the profits (or losses) of the business. The laborers receive wages, often miserably inadequate.

A very common example of this case in this country is where a merchant as business manager invests a small capital and buys goods systematically on credit, renting a building and hiring clerks. In this instance the capitalists are the owner of the store who receives rent, and the wholesale dealers of whom goods are bought on credit, who receive interest directly, or indirectly in the enhanced price of the goods, and perhaps also the bank of which the merchant secures accommodation loans from time to time, paying a high rate of interest. The business manager is the merchant who receives interest on the capital he has invested, salary as business manager, wages as salesman, and the profits (or losses) of the business. The clerk or clerks receive wages. I need not say that the result of doing business in this way is in nine cases out of ten a net loss, which falls either upon the merchant or fully as often upon his foolish creditors, the wholesale dealers.

A variety of this case which almost deserves to be set off as a case by itself, is when the business manager gives the capitalist a share of the proceeds or of the net profits in lieu of interest or rent. The most familiar example of this is where a farm is rented on shares. This is the usual method in the United States of renting farms, when they are rented at all. It is also, under the name of Metayer rent, the usual method in France and Italy. In this method of carrying on business, the distribution to the laborer is wages; the distribution to the capitalist is rent in the form of a share of the crop, which on the average of years is more than a fair money rent. But this is usually more than offset by the tenant's neglect to keep up the land, as he holds only from year to year. And the distribution to the business manager who in this case is the tenant, is interest on the capital he has invested, if any, wages for his own labor and net profits (or losses) after paying any laborers he has hired and giving the landlord his share of the crop.

CASE V.

In this case an association of laborers borrow capital and employ a business manager who may or may not be one of their own number. This case is a favorite one with many persons in theory, but it has never thus far been found to work well in practice. To avoid misconception, it should be noted that corporative stores do not come under this case. The laborers who organize a corporative store, do not as a rule work in the store, and are therefore in regard to that business not laborers, but capitalists. They are really a stock company to carry on a mercantile business and therefore come under case III. as we have already seen.

But when journeymen shoemakers, for instance, form a co-operative association, they come under this case. As in all kinds of business, capital is needed to begin it and to carry it on. This capital may possibly be obtained in one of three ways: (a) By borrowing money of some capitalist, which could not be done ordinarily; or (b) by renting a shop and buying materials on credit, a hazardous undertaking both for the association and for the capitalist; or (c) by combining their separate earnings, which would be the usual method. In this case the association as a combination of capitalists employs its own members as business manager and laborers.

This case in the last form differs from case I only in being the case of a combination of individuals instead of a single individual, that combine in one the three functions of capitalist, business manager and laborer. But in this case, while there is no distribution between the association and outsiders, there is a question of distribution between the members of the association. Of the various methods which might be adopted, the following is the most in accordance with the principles of political economy. Let the members be credited with the capital advanced by each as so much stock in the association; let the members be paid for their services at the market rates, and if possible, by the piece and not by the day, and after paying these wages and other expenses, let the members divide the profits or losses on the basis of the capital advanced by each, like any stock company. All these five cases have their place in the transactions of business, and every form of

productive industry must fall under some one of them. I summarize them in closing:

Case I. Where the same person is capitalist, business manager and laborer.

Case II. Where the capitalist and business manager are the same person, employing laborers.

Case III. Where the capitalist employs the business manager and laborers. All business corporations are a variety of this case.

Case IV. Where the manager carries on the business, borrowing or renting of the capitalist and employing laborers.

Case V. Where an association of laborers employ themselves and furnish their own capital.

WEALTH, CAPITAL AND CREDIT.

By J. B. Parkinson, of Madison.

Macleod in his "Theory and Practice of Banking" asks why political economy has not yet attained the same rank as an exact science as mechanics, and answers, "because the same care has never yet been given to settle its definitions and axioms." In this answer we are furnished with but a fraction of the truth. A deeper reason is, its definitions and its axioms are far more difficult of settlement than those pertaining to mechanics or to any of the more exact sciences.

Political economy labors under special disadvantages. Its close relation to the moral sciences, whose circles certainly touch if they do not overlap, brings it continually into contact with feelings and prepossessions which are nearly sure to leave their impress upon the discussion of its principles. Its conclusions, too, from the very nature of the subject matter of which it treats, have a direct and visible bearing upon human conduct in some of the most exciting pursuits of life, while its technical terms by a sort of compulsion are taken from the language of the people, and must partake in a greater or less degree of the looseness of colloquial usage. Its growth seems slower than it really is, for it belongs to a class of sciences whose work can never end. The chief data from which it reasons are human character and human institutions, and whatever affects these must continually create new problems for its solution.

Of disputes about definitions there is no end. They are rife in every science. In political economy they are especially so, and chiefly for the reasons above stated. Disputes of this character are usually harmless, and not uncommonly stale and unprofitable. But there *are* economic questions of vital import, such as reach to the very essence of things, about which we do not find that harmony which would seem to be essential to healthy and rapid progress.

The subject to which I desire to call attention chiefly at this time is credit, but before doing so, it is important to pass in brief review two or three other terms which lead up to and are necessarily involved in any discussion of credit.

The first of these is value, an important term in Political Economy, and one almost necessarily concerned in every economical discussion. A misapprehension of the nature of value will vitiate all reasoning upon questions of economy and finance. The term is a relative one, and herein lies the chief difficulty. That which is absolute the mind can seize and hold, but mere relations are apt to slip the grasp at every turn. Value always implies a comparison. It is the relation which one thing bears to another as made known by an act of free exchange. In other words, exchange, which is a sort of equalizing of estimates, alone gives expression to value. It would be just as reasonable to attempt to determine a ratio by considering one of its terms only, as to attempt to ascertain the value of a thing without comparing it with something else.

Another term closely allied to value, and which is made the central word in most of the definitions of political economy, is wealth. This, also, like other terms which this science is compelled to use, is taken from every day language, and is sometimes employed in a vague, and often in a metaphorical sense. "Every one," says J. S. Mill, "has a notion, sufficiently correct for common purposes, of what is meant by wealth. The inquiries which relate to it are in no danger of being confounded with those relating to any other of the great human interests" While this is true, yet, as Mill himself shows, the most mischievous confusion of ideas has existed upon the subject, which for generations gave a thoroughly false direction to the whole policy of Europe. Under the so-called "Mercantile System," nations in their intercourse with each other assumed, either expressly or tacitly, that money and the precious metals capable of being converted directly into money were alone wealth — that whatever sent these out of a country impoverished it, whatever tended to heap them up in a country added to its wealth, no matter what or how much of other commodities was given in exchange for them. These crude notions have in the

main been dissipated, yet some traces of them still linger and often crop out in discussions upon what is called the balance of trade. Disputes about wealth still go on, but they are mainly over distinctions of metaphysical nicety. Political economists are substantially agreed as to the nature of the thing itself, and only quarrel about whether this or that shall be admitted to the category. In the language of the logicians, they differ about the term in extension, not in intension.

Prof. Perry, however, holds that it is impossible to frame any definition of wealth which will render the word fit for scientific use. He has written a book about wealth without stopping to define it. It is a work of much merit, but is marred, it seems to me, by the author's persistent attempt to ignore this term. Nothing is gained by calling political economy the "science of exchanges," or the "science of value." The question What is wealth? must still be met, for to wealth only do exchanges apply or does value attach. Wealth is usually defined, and I have no new definition to offer, as "anything which can be appropriated and exchanged." The essential requirements are that it shall possess utility, or the capacity to satisfy desire, and be the result or embodiment of labor. Hence, as a generic term, it includes all objects of value and no others. It is usual to include in wealth material things only — such as may be accumulated, stored. Such limitation is more in accordance with the popular notion of wealth, although strictly and logically the term includes more. The question of wealth or not wealth does not absolutely turn upon the length of time a thing may be enjoyed, nor upon whether it may be seen or tasted or handled. The primary source of wealth is the free bounty of nature. The secondary source is labor which also gives the right of possession. Nature is liberal in her gifts, but she rarely offers them in a condition just ready for man's consumption. Man begins where other animals end. They use nature's gifts as they find them. He, like them, partakes of her fruits, but is expected to fit them for his use by rational effort. The accumulated wealth of the world is but the result of the application of labor to the materials furnished at free hand. Wealth and capital must not be confounded. The former includes all objects which may be

appropriated and exchanged, the latter, such only as may be employed in production, or at most, such as are set aside for productive purposes. Hence, all capital is wealth but all wealth is not capital. Wealth is generic, capital is specific. Capital is sometimes called labor of the past. It is the result rather of the combination of past labor and natural agents. The knowledge and skill of workmen also are by some included under the head of capital. There are grave objections to such a classification. It tends to break down all distinction between capital and labor, or rather, between capital and laborers. All labor implies a union of physical and intellectual effort, and the same reasoning which is urged in favor of reckoning the acquired knowledge and skill of the laborer as a part of capital would, if followed to its logical results, include his physical strength also in the same category. It is claimed that men sell their skill — their intellectual and physical dexterity. If this be true, then they also sell their mere physical powers. The truth is they sell neither. The *results* of each are bought and sold in the market — not these powers and capacities themselves. It is a characteristic of the latter that they are retained and used — not parted with at all. Nor is the skill of a mechanic, strictly speaking, something owned. Possession implies something outside of the possessor. Knowledge and skill and physical power go to make up the man, — they are a part of what he *is*, not what he *has*. Labor helps to create capital, and the powers of the laborer, whether natural or acquired, are potential labor.

We are now in a better condition to understand the nature and chief functions of credit. As the etymology of the word signifies, credit is trust — confidence. Prof. Fawcett defines it as "power to borrow." From the standpoint of the borrower this is correct, but back of this power and essential to its exercise is the trust imposed by the creditor. In its generic sense, credit is implied in all mutual dependence and mutual helpfulness. Without it, society would be impossible and human intercourse practically at an end. As applied in the affairs of life, credit is reliance on the integrity, energy and skill of one's fellow men, and the extent to which it may be safely carried is one of the highest

tests of civilization. It is neither wealth nor capital — does not of itself create either. It brings wealth into the form of capital and thus gives experience to the industrial talent of a country. All written instruments of credit, when in use, whether in the form of book accounts, bank bills, checks, bills of exchange, or what not, are tangible evidences that trust has been imposed and that the power to borrow has been exercised. But credit may be signified by spoken words, as well as by written, or even without the use of either. Prof. Perry says "credits are debts not yet realized," meaning probably that instruments of credit are evidences of rights not yet realized, and obligations yet unfulfilled. Credit creates rights and rights imply obligations. The terms are reciprocal.

All this seems plain enough, but it is only by holding fast to elementary truths that we can hope to reason clearly upon any subject. More fallacies cluster about and take root in the subject of credit than in any other within the whole range of political economy. They find expression everywhere, but especially in language and legislation connected with taxation and the currency. Chief among these is the notion that evidences of debt are wealth. It seems to me that some political economists of high standing are not wholly free from responsibility in this matter. Even John Stuart Mill, who usually weighed his words with great care, has used language in the preliminary chapter of his "Principles of Political Economy," which even taken as a whole, if not absolutely inaccurate, is difficult to reconcile with his own teachings elsewhere, and is certainly misleading. He attempts to draw a distinction between wealth as applied to the possessions of an individual and to those of a nation or of mankind. "In the wealth of mankind," he says, "nothing is included which does not of itself answer some purpose of utility or pleasure. To an individual anything is wealth which, though useless in itself, enables him to claim from others a part of their stock of things useful and pleasant. Take for instance a mortgage for a thousand pounds on a landed estate. This is wealth to the person to whom it brings in a revenue, and who could perhaps sell it in the market for the full amount of the debt. But it is not wealth to the

country; if the engagement were annulled the country would be neither poorer nor richer. The mortgagee would have lost a thousand pounds, and the owner of the land would have gained it. Speaking nationally, the mortgage was not itself wealth, but merely gave A a claim to a portion of the wealth of B. It was wealth to A, and wealth which he could transfer to a third person, but"—and here comes in a saving clause which contains the essence of the whole matter—"that which he so transferred was a joint ownership, to the extent of a thousand pounds, in the land of which B was nominally sole proprietor." The public funds of a country are in precisely the same category. Mr. Mill says they cannot be counted as part of the national wealth, but intimates in one breath that they are a part of individual wealth, and in the next wipes out the distinction. They are not real wealth at all, neither national nor individual. The fundholders are "mortgagees on the general wealth of the country;" the funds indicate liens upon that which is real and tangible, to be drawn ultimately from the tax payers of the nation. Mr. Mill also gives countenance to a distincton between the wealth of a nation and that of mankind. "A country," he says, "may include in its wealth all stock held by its citizens in the funds of foreign countries, and other debts due to them from abroad." But, as if not quite satisfied with this statement, he adds, "even this is only wealth to them by being a part ownership in wealth held by others. It forms no part of the wealth of the human race."

There is in reality no distinction between the wealth of an individual, of a nation and of mankind. Individual wealth is and must be a part of national wealth, and national wealth is and must be a part of the wealth of the human race. If the context were always carefully read in explanation of the text, Mill might perhaps be safely allowed to answer Mill. As it is, his insufficiently guarded words at this point have helped to perpetuate the thousand and one fallacies which find expression in discussions about currency, banking and taxation.

Professor Perry has taken his stand without qualification on the economic theory that credits, rights, claims are property, meaning by property wealth or capital. The term property is an

exceedingly ambiguous one. Not to speak of its various secondary and metaphorical uses, it is employed in two important and totally distinct senses. In a purely legal point of view, it is the right or title to a thing — ownership. But in the more common and popular sense, and the one in which alone political economy is concerned about it, it is a tangible entity — the thing owned — that upon which the claim is based — that in which the right or title inheres. In this sense there is no difference between property and wealth. "The test of property," says Professor Perry, "is a sale; that which will bring something when exposed for exchange is property; that which will bring nothing, either never was, or has now ceased to be, distinctively property." But Professor Perry holds that credits, rights, claims, are property; that property is or may be capital, and that all capital is wealth. It seems to me there is a fallacy here, and that it lies in considering that what are bought and sold are mere rights and claims, separate and distinct from the entities in which the rights inhere, and to which the claims attach. Strike the property out of existence upon which a claim rests, and the claim disappears with it. Destroy a man's claim, on the other hand, or all evidences of it, and the property remains — the ownership simply changes hands.

If titles are property in the sense of wealth, it would seem that a community has an easy road to fortune. Its farms and other real estate are wealth; they need only be mortgaged to create as much new wealth in the form of personal property. If mere titles are property, then the wealth of the nation or, is you please, of the individuals of the nation, may at least be doubled without any appreciable expenditure of time or labor. The truth is, wealth is something valuable and which has become so through the application of labor, and a title to it, or a claim upon it, or a representation of it, can no more be wealth than a shadow can be substance.

The notion that titles and claims are property finds ample expression in tax-laws. Few countries afford better opportunities for testing methods of taxation than our own, but none certainly can exhibit such an array of incongruities. The ease with which property is accumulated makes us less considerate of expenditures

and leakages. Under the plea of equalizing the burden, our general theory seems to be to tax everything without inquiring whether it be a symbol or a reality, a lien upon a thing or the thing itself. The result is, the very inequalities we would obviate are aggravated. If political economists of high standing insist not only that real estate is property, but that mortgages upon it are also property, is it strange that legislatures enact that each shall be taxed? Touching this question, the conclusion of Judge Foster, set forth in his dissenting opinion given in the somewhat celebrated case of Kirtland vs. Hotchkiss, heard before the Supreme Court of Errors of the State of Connecticut, seems almost axiomatic. He said:—"Property and a debt, considered as a representative of the property pledged for its payment, constitute but one subject for the purpose of taxation. The tax being paid on the property without diminution on account of the debt, nothing remains to be taxed. The debt, indeed, aside from the property behind it, and of which it is the representative, is simply worthless." We may call what we like, property or wealth, and governments may determine that all property, including imaginary things and legal fictions, shall be taxed, but nothing short of omnipotence can make something out of nothing, or collect taxes from symbols. "It is property in possession, or enjoyment, and not merely in right, which must ultimately pay every tax."

Rights and titles and claims are elements in the distribution of wealth, not in its composition. They attach to pre-existing property and may be multiplied indefinitely. Any tax upon them is only another means of burdening the property that lies behind them.

But it is in connection with the currency that credit wields its chief influence, and may work its greatest mischief. Leading writers upon political economy and finance have done much to instill correct notions of money and its various credit substitutes, and their responsibility in this direction can scarcely be over-estimated. In this light, it is at least an open question, whether the views of Professor Francis A. Walker, as set forth in his late work on "Money," and also in his later one on "Money, Trade and Industry," do not give some encouragement to the numberless

fallacies that are afloat upon this subject. Professor Walker has done excellent service in the economic field. He always writes with clearness and vigor, and whatever he says upon any topic is sure to command attention. "Money," he says, is that which passes freely from hand to hand throughout the community, in final discharge of debts and full payment for commodities, being accepted equally without reference to the character or credit of the person who offers it, and without the intention of the person who receives it to consume it, or enjoy it, or apply it to any other use than in turn to tender it to others in discharge of debts or payment for commodities." This is an almost faultless description of money as a fact, and if we were dealing with facts only and not with their interpretation, it might be allowed to pass without comment. The core of this description lies in the words "final discharge of debts and full payment for commodities." In their correct interpretation rests the whole matter in dispute. In the view of Professor Walker the question, money or not money, is, in respect to anything that could be taken, wholly a question of degree — the degree of the extent and facility of its use in exchange. If the thing be a paper promise, another distinction is called in, which is that the promise must be that of somebody else, and not of the one who offers it. "If I purchase a farm from any one," he says, "and give him my promise to pay him at some future date, that promise, whatever form it takes, whether written on paper or stamped upon brass, whatever my character or competence, whether I be rich or poor, honest or dishonest, is not money. The goods are not yet paid for, but are yet to be paid for. I have taken credit; I have not given money. The seller still looks to me for the equivalent of the goods he has parted with. * * * I buy a horse, and give the owner thirty $5 notes. Have I taken credit? Not at all; I have paid for the horse. * * * He takes the notes from me because they are money — that is, because they have such general acceptance throughout the country that he knows men will freely and gladly take them from him whenever he wishes to buy anything."

As a matter of fact, the credit element enters into both of these transactions. In each case it is between the maker of the prom-

ise and the receiver of it. In the one case the promise is made directly to a particular person, in the other it is made to bearer. In the one case the maker is an individual, in the other, a collection of individuals or corporation. In each case the maker of the promise is held under the law, more or less perfectly, to its fulfillment. According to one distinction made by Professor Walker, neither the bank bill nor the promissory note is money, as between the bank or the individual maker and the holder of the bill or note. But between other parties and according to the other distinction, which turns upon the degree of currency, he holds that the bank bill is money, and the individual note not money. But a man may be so widely known, his integrity be of so high a character, and his means so ample, that his promise may be just as good and just as current as an ordinary bank note. The one may be called money and the other not. The law may determine that an acceptance of the one shall be a bar to any further recourse upon the party from whom it is received, and that an acceptance of the other shall not be such a bar. All this lies close to the surface. It does not reach to the root of the matter. The question, money or not money, can never turn solely upon the "degree of currency" of the thing in use. This depends upon time and place and other circumstances, and attaches even to gold and silver as well as to the different substitutes. The distinction lies deeper. Money pays, but every paper substitute bears upon its face the evidence that it does not pay in the full and complete sense of the term.

But, says Professor Walker, "to say that a bank note is a promise to pay money is to beg the question. A bank note is a promise to pay gold or silver, and therefore, if you please, is neither gold nor silver; but wherefore not money? Money is that money does; and the bank note performs the money function in every particular." In this last sentence he himself begs the question, and, although unintentionally, gives aid and comfort to the advocates of "fiat" money. The bank note promises to pay francs or pounds or dollars, and these have a definite and well understood meaning. They are a "material recompense or equivalent" — are wealth and really pay for wealth. Money

proper conforms strictly to Prof. Walker's own description; promises to pay, or orders to pay, of whatever name or nature, do not so conform. Money passes from hand to hand throughout the community in final discharge of debts and full payment for commodities by no magical process, nor because it is called money, or declared to be money by an edict of the government, but for the reason that it is a complete equivalent. Bank bills, promissory notes, checks, and various other credit instruments, take the place of money in part by serving some of its purposes, and it is because they do so that they become so dangerous in actual use, if not properly guarded. But they serve these purposes not through any force of their own, but as representatives. Their energy is not primitive, but derivative. They are not actual equivalents, but claims, only, or evidences of claim, upon that which is an equivalent; and when the principal in whose name they act disappears, their force and authority is gone. Professor Walker, in his whole characterization of money, largely ignores its most delicate if not most important function — that of serving as a measure of wealth or standard of value. Almost anything which the parties concerned may agree upon will serve as a medium of exchange — a bank bill, a check, a note of hand, "a chalk mark behind the door, a notch in a stick, a wink at an auctioneer" — but very few things will serve well as a standard of value. To do so, they must themselves be valuable, that is, be objects of general desire and the results of labor. They must be something that pays as it goes — that walks by sight and not by faith — that, when accepted, leaves no recourse upon anybody, either in law or equity. No credit instruments can fully meet these requirements. The distinction is vital. Ignore it, and the floodgates are open for all sorts of money and all sorts of notions about money.

THE NATURE AND FUNCTIONS OF CREDIT.

A. L. CHAPIN, D. D.

Some exercise of trust between man and man is essential to the very existence of human society. Trust implies two things; first, an intellectual belief in the truthfulness and integrity of one's fellow-men; and second, a blended feeling of dependence and reliance in mutual relations and intercourse. As civilization advances, this element of trust enters more and more into all the various intercourse of mankind, and its extent and the soundness of its basis become a sign of the social condition and moral character of a people.

Credit is but a technical name for the trust which runs through all the manifold processes of productive industry and commerce. It is indispensable to the effective division of labor and to the free and advantageous exchange of the products of labor. It pervades the business operations of men the world over, as that subtile agent, light, pervades the material universe. Its operations are most minute in their details, most magnificent in their range and most grand and sometimes terrible in their results. It seems a very small affair, when the butcher enters on the poor sewing-woman's market book a daily bit of meat, expecting the account to be settled at the end of each week. It is nevertheless an operation of credit, not altogether insignificant to the parties concerned. You look with wonder at the silent manipulations of the bank clerks as they pass in procession along the desks of the New York clearing-house, and when you are told that what is done there in that one still hour of the day adjusts thousands of commercial transactions and redistributes a hundred millions of wealth, you get some conception of the vast complications of this agency we call credit. And when you hear that the nod of the autocrat of the Rothschild's bank, settles questions of peace and war between conflicting nations, you apprehend what a power this agency, credit, is in human affairs.

The word credit is in common use, employed quite vaguely,

and the indefinite use of the term has confused the discussion of many economical problems, and led to erroneous opinions. In its correct use, the radical meaning of trust — that mental exercise which includes an intellectual judgment and a feeling of reliance, must always be kept prominent. Credit is always a subjective thing with the man who trusts rather than an objective quality of the man trusted. We speak loosely of a man's credit, meaning something in his character or condition which is a power to command credit. The real measure of his credit is, however, the estimate in which he is held by others. Swindlers understand this very well, and their efforts are never to perfect in themselves trustworthy qualities, but by whatever deceptive arts, to mislead the judgment and to win confidence in their favor. Judgment and feeling are very closely identified in the exercise of credit. The normal exercise requires that the judgment should regulate the feeling, but too often this order is reversed; the feeling runs away with the judgment. Hence over-confidence unduly expanding credit, at one time, followed by the reaction of panic, when unreasoning distrust paralyzes all business activity.

As a technical term in the science of Political Economy, "Credit is Trust in the promise of an equivalent to be rendered at a future time for values immediately transferred." It supposes one of the highest acts of human free-will, a contract between two parties, in which a present advantage conferred is balanced by an obligation to be fulfilled in the future. The possibility of thus entering into a contract and its binding force proceed from two capacities of the human mind, viz., foresight and freedom. For a present consideration, anticipating future resources, a man freely binds himself by an expressed intention respecting a future act, surrendering his right to change that intention. It is evident then that the soundness of credit, the strength of trust, in a particular case or in regard to transactions generally must be determined by the care with which such obligations are assumed and the sacredness with which they are regarded.

The true basis of credit is real wealth, existing or prospective, which is or is expected to be at the command of the party trusted. Credit is never self-supporting. It does not go alone. It can

neither walk nor fly. The waxen wings of imagination on which like Dædalus, it sometimes boldly starts forth are quickly melted and its fall is swift and ruinous. Credit must ever and anon feel under it the solid ground of real wealth. The promise must meet the test of actual fulfillment. Thus our first thought recurs again. The essence of credit is confidence in these two things which are its inseparable supports, the truthfulness and the probable ability of the promisor,—a moral and a material property joined.

Money as a commonly accepted measure or standard of value, fulfills an office of the highest consequence in all operations of credit. Except in rare, special cases, it furnishes the terms of the contract. Values immediately transferred are set down in terms of money, which fix the measure of values for the deferred payment. If meantime a change occur in the purchasing power of money, the actual effect of the contract is materially changed to the disadvantage of one or other of the parties. Hence, whatever causes fluctuations in the quantity or quality of money, disturbs credit. That steady, healthful trust which we have seen to be the essence of credit can never be maintained with unstable currency. To this cause mainly we must refer the distrust which prevades the business of our country to-day, and in the midst of of abundant resources paralyzes industry and brings thousands of our stalwart, enterprising people face to face with abject poverty. In the very nature of things, the co-relation between money and credit is close and constant. An unnatural increase in the quantity of that which passes for money by turning certain forms of credit into money, as we saw in the issue of the government greenbacks fifteen years ago, tends to a much greater expansion of credit. The artificial stimulus of this double expansion produces in all business a delirium of intoxication. While the excitement lasts every thing runs wild. But the reaction and collapse are sure to come. We are living now in the day after the debauch. Oh what headaches, what nausea, what exhaustion do we meet on every hand. We wake as from a dream and wonder how we ever suffered our trust to be imposed upon. We look upon the wrecks lying all around and clutch the little we can

gather of what is left, afraid to trust anybody more. Would to God this sad experience might open men's eyes to understand the nature of credit and to hold it henceforth within its true limitations under wise regulation.

As I now pass to speak of the functions of credit, I must notice two or three false notions which are more or less current.

1. Credit is not wealth nor capital. It is only a means or occasion for transferring wealth from one to another. A farmer takes from the manufacturer a plow, and gives in return his note payable at the end of six months. When the contract is made, there is but a single item of wealth, the plow. The note given is but the symbol or evidence of its value transferred. Neither the promise on the part of the farmer, nor the trust on the part of the manufacturer has value in itself. The payment of the note, then, is only the return in another form of the one value. If during the period of the contract new wealth has been created, by the use of the plow, it is only as that item of wealth has been made capital, so as in union with labor to become productive. The credit received has merely adjusted the transfer of the one value. Proceeding on the false notion that credit is capital, ninety out of every hundred merchants fail. The false notion still governs the legislation of almost every state in our land, and leads to double taxation, because symbols, mere evidences of debt, are regarded as of the very substance of wealth.

2. Credit does not of itself create capital. It has no original power to make something out of nothing. Wealth does not grow by the mere act of passing from hand to hand. Its increase comes only from its union with labor. The mere multiplying of promises to pay does not make a man rich, as many a deluded creditor has learned to his sorrow. Can a nation, any more than an individual grow rich by that process?

3. The trusted promises of credit in certain forms may be thrown into general circulation, but they are ever simple evidences of debt, and as they pass from hand to hand they do nothing more than transfer the debts for which they were originally issued. This is only saying that an item of wealth cannot be used at the same time by both its owner and the man to whom it

is lent. Sixteen years ago, a woolen manufacturer furnished the United States government with four pairs of army blankets, and accepted in return its promise to pay ten dollars, — the term dollars meaning a certain weight of gold or silver. A., the first receiver of that bill of credit, could have no use of the article he had loaned the government, or its value, till he passed it to another, B., for an equivalent item of real wealth. B. passed it in like manner to C., and so it has been moving on through five hundred different hands, till it has come to me. In every transfer it has just passed along that original debt of the United States government. It is to me just what it was at first, a mere promise of a certain weight of gold or silver to be rendered at some future time. Suppose that to-morrow the government, by word or act should break its contract by turning the word dollars into a mythical term meaning neither gold or silver, or any other form of real wealth, only an ideal something to count by, who then will take it at my hands in exchange for any substance of real wealth? It and the thirty-five millions of outstanding promises like it, would drop like the leaves in Vallambrosa's vale, dead and worthless.

Now to speak more positively, we may define four distinct and important functions of credit.

1. Credit is a most effective means of uniting capital and labor for the production of wealth. It is not itself capital and cannot create capital, but it does greatly increase the sum of wealth available as capital for profitable uses. A thrifty mechanic leaves as the fruit of his life's labor, a large shop well appointed with machinery and tools. But his widow who inherits the estate can do nothing with the property in this form. Across the way, is a young man who has strength and skill and all needed qualifications for business, but is destitute of capital. The widow rents her establishment to the young workman, and so credit joins the labor of the past with present labor for fruitful production and profit to both. But for this interposition, both must have been idle. In every community there are many engaged in active industry who yearly lay by little savings which they cannot use themselves. If there was no such thing as credit, all this wealth,

amounting in the aggregate to millions, must also be idle or be wasted in unskillful and unsuccessful attempts to make it yield a profit. Meantime hundreds of vigorous men must also be idle for lack of this very capital to work upon. Credit is thus indispensable to draw out the entire capital of a country and also to develop most completely the industrial talent of the people. It becomes thus the very spring of industrial enterprise. The sound and healthy exercise of credit, is of the utmost consequence to the laboring classes.

2. Credit quickens exchanges. The plowmaker's winter work gives him a large stock of plows in the spring. The farmers want the plows in the spring, but they are to derive the means of paying for them from the harvest. If no sale could be made till the means of purchase were in hand, business with both parties must be suspended. Through credit the exchange may be made at once. As in this particular case, so of ten thousand other things, credit turns them off at once, and capital on every hand is rapidly turned over. It is thus an important function of credit, to keep all the channels of business stirring with life and activity. By it articles are brought within reach just when they are needed. By no other means could the market be kept constantly supplied.

3. Credit serves directly as an instrument of exchange. The simplest phase of this function is in ordinary book accounts. A. buys of B. on credit, and B. buys of A. on credit. At the year's end the books are balanced by the payment of the difference or by simply carrying it over to begin the annual account for the next year. Here exchanges are really made in kind without any of the inconveniences of barter. This is ramified and extended indefinitely, not only between individuals but between cities and nations all around the world, and the greater part of the exchanges is resolved into exchanges in kind. The trade of Milwaukee to-day is mainly an account of credit with all other cities of the country and the world with which she deals. The amount of money invested in these exchanges is insignificant compared with the values which are transferred through this agency of credit.

4. Credit puts every man's wealth at his disposal just when he wants to find and use it. A thrifty farmer finds when his harvests are all gathered in that he has ample provision for his household for a year, and a thousand bushels of wheat beside. He concludes to devote this surplus of his wealth to his own improvement by travel abroad. How can this thousand bushels of wheat be made available for that? What he will really need is the means of locomotion and something to eat and wear, wherever he goes. How shall he get those things out of his present form of wealth? He can't well carry his wheat with him. If he turns its value into money, it will be difficult and dangerous to carry so much gold and silver with him. Credit solves his problem. Through the wheat buyer at home he may pass his grain into the great channel of commerce, and it is made at once the basis of a circular letter of credit which he can put into his pocket in the assurance that in any one of the two hundred cities of the old world named therein, he will find a correspondent of his banker, who, on seeing the letter will furnish him the means of obtaining whatever he may need, asking only that he leave his own autograph attached to a receipt behind him. Possibly he may find himself at a restaurant in Paris eating bread made of his own wheat. However that may be, through this wonderful function of credit, his wheat will carry him about everywhere, supplying all his wants till its value is exhausted. The letter in which he puts his trust, commands for him everywhere the trust of others whom he never saw before and never will see again.

With reference to all these functions of credit, however, it is to be remembered that a basis of sound money is indispensable. Real money is the ballast of the ship of trade. Credit furnishes the sails. Any ballast that easily shifts in a storm is sure to bring danger to the ship. The credit which controls the world and binds all civilized nations together by the interests and mutual service of universal industry and commerce, must be sustained by the all-prevailing presence of money whose value is uniform and stable. Quality in this matter is of more consequence even than quantity. The nation that robs its money of these qualities of stability and uniformity with that of the rest of the world, shatters

its credit and rules itself out of free and equal commercial relations with other nations.

Speaking, as I do, in the city of Milwaukee, let me say before I close, that I have been well situated to observe the commercial development of our state, and especially of this city, almost from the beginning. It has been, in the main, a healthy, prosperous development. Our credit has been stable and unquestioned, not convulsed and bankrupted, as has been the case with states on either side of us. Milwaukee, I believe, has stood the severe test of the recent financial revulsion in the commercial world, better than any other western city. Comparatively few failures have occurred. This favorable condition, it seems to me, is due in no small degree to the steadying influence of an institution early established here, almost by an evasion of law, as an agency of credit to meet the ever pressing need of industrial enterprise. When in the phrensied hostility to a paper currency, caused by fraudulent operations of wild speculation, banks were in disrepute and almost entirely disallowed through all this western country, the Wisconsin Marine and Fire Insurance Company, issued its certificates of deposits, and they went into general circulation, because they met an absolute pressing necessity. The institution performed all the functions of a bank without the name. The public confidence had nothing to rest on but the honor and integrity of the managers, who put some real capital into the venture and sought profit for themselves only in identification with the advantage of the community. But there was a basis of solid capital and a great deal of Scotch honesty and thrift in the management, and so the operations were sound, the promises were made good, and the institution greatly aided the rapid unfolding of wealth in our state and in the whole region. It was subjected to more than one fiery ordeal under the efforts of enemies to break it down, but it triumphantly withstood all assaults, and stands to-day in strength and honor, the leading banking institution of our state, identified through all its history, with every branch of vigorous productive industry. If it has brought wealth to its proprietors, it is but a fit reward for what it has done to increase the wealth of the whole community.

I refer to this institution only as an illustration of what sound banking is, and of what it does for the common weal. Banking is simply *the chief agency of credit*, and its true function is at the same time to facilitate and to regulate all operations of credit, so as to draw out to the utmost the resources and energies of a people in fruitful industry. Rightfully managed, on a sound basis, it is an agency for unspeakable good; on an unstable basis, abused for purposes of greed and fraud, it is an instrument of unspeakable mischief.

NATURE AND THE SUPERNATURAL.

J. J. ELMENDORF, S. T. D.

I am somewhat afraid that the subject of my paper may lead some to suppose that I am introducing theological discussion into the transactions of the Academy. If I should fall into this error it will be unintentional on my part, and I beg pardon in advance. Concerning my own views of the truth and meaning of certain wonderful events recorded in documents which profess to be historical, there need be no question. But I do not see that my views on these points need affect the philosophical and scientific problem which I submit for investigation. I propose it in the same spirit as far as is possible, as if the question concerned the history of India, and a narrative of Buddha. Philosophy and science cannot ignore what is immediately around them, viz.: a very general reception of certain extraordinary narratives of various kinds; and it is a question to be considered whether there is any case to come before the bar of philosophy or science, or whether these must relegate the matter to another tribunal, since they are incompetent to decide it.

The problem, briefly stated, is this: Inasmuch as nature with its rigid mechanical laws is not inconsistent with the freedom of man, does the admission of the supernatural as an element in the facts which come under our notice conflict with scientific laws, so that it must be rejected at once? or is the sphere of the supernatural, so called, a different one, like that of man's will and reason, so that inductive science may pursue its work undisturbed in its own sphere, leaving the other to its own special students, but accepting conclusions in the moral sphere, as mankind in general accept those of the scientific expert.

From the oldest historical records down to the contemporary witness of some leaders in natural science, concerning wonderful events occurring in England or the United States, we find a series of such marvels recorded, some having a very high degree of

attestation in their favor, and some little, if any; the latter chiefly showing a predisposition on the part of many or all to accept the truth of such narratives, which predisposition is itself a psychological fact and demands investigation. But all these narratives have the common ground that they are referable to no well established rules of the phenomenal world which surrounds us, and some of them are so different from ordinary experience as to excite our wonder and tax our powers of belief in the highest degree, even if they are not at once dismissed as unworthy of a rational man's attention.

Some of these facts, so called, are denominated "miracles," and are viewed with reference to moral purposes and treated as evidences of a Divine revelation or of some moral truth. But the events recorded have their scientific relations, because phenomena of nature are said to have been presented to human senses; and they have their philosophical relations, because the asserted facts, whether true or mere inventions of fancy, call for rational explanation. Now my proposition is, that neither science nor philosophy give any antecedent reasons, any *a priori* ground, for rejecting facts of this nature. The question is simply one of their historical evidence, and must be referred to that bar for judgment. When criticism has sifted the evidence and given its verdict, if that verdict be favorable, science may examine the facts so far as the experience of others can be examined; science, *if the antecedents can be repeated*, may verify the results (if the antecedents do not admit of repetition the results cannot be verified); and philosophy will try to explain the facts. If the testimony is rejected as insufficient, there will be no case to come before this court, but the claimant will not have been pre-judged.

And furthermore, that the historical facts should be reconcilable with philosophy and science, it will not be necessary that my view of the case be *demonstrated* to be correct. If only it be a *possible* one, then also the reconciliation will be possible, and my end will be attained.

Let me repeat then, more fully, what I wish to exclude from our discussion: (1) the credibility of the asserted facts; (2) their value, if true, as evidences of any moral or religious truth;

(3) I wish also to exclude any question whether some or many narratives of wonderful events found in ancient and Oriental sources may be presumed to be poetic and allegorical presentations of moral truth, e. g., the story of the tempting of man by a being in the form of a serpent, or that of the Hebrew, Jonah. One single narrative found in the Christian New Testament, and narrated as an actual occurrence, or one of the marvelous experiences of a distinguished English naturalist, is sufficient to determine the question before us.

For the purpose of our discussion, then, it will be expedient to admit, hypothetically, the narrative as a statement of facts which actually occurred, *i. e.*, of sensible phenomena stated, not scientifically, which statement would assign the facts to a known law, but as they would naturally be reported by honest and intelligent eye-witnesses, telling what their eyes saw, their ears heard or their hands handled. It is, of course, at once open to remark from the scientific point of view, that the subjective impression of the phenomenon, together with the ordinary and accepted interpretation of it, is all that any man can report, and for all practical purposes it is sufficient. Philosophy and science proceed further, to some explanation, partial at least, of the marvelous occurrence. For example: if, as one narrative states, the commander of an army made a prayer that the sun might stand still, and the narrative be not poetical imagination,[1] but a historical statement, the phenomenon which followed is all that can be attested. There is not, necessarily, declared to have been a suspension of the sun's daily motion around the earth or any other *scientific explanation* of what the eyes saw.

I.

This being premised concerning historical modes of narration, I must assume some propositions as postulates, without attempting any proof of them; for some are needed, otherwise we could never find a beginning for our investigation.

(1) The world of nature is known to us as phenomena, infinite in number, and, potentially, infinite in variety; phenomena empi-

[1] As in the Chanson de Roland.

rically known, i. e., known only in and through our senses, inner and outer.

(2) Laws of nature are rules for us, the discoveries of our understanding that there is such harmony among the facts as we view them, that they can be classified. These laws are, objectively, *incomplete registers*, extending only to as many facts as have come under our notice; but experience finds them serviceable in anticipating facts of a similar kind. And the *rational* principle of the uniformity of nature, which is given by our reason, and not merely by empirical observation, and which is rationally grounded on the one unchanging nature of the cause which, or the being who, produces the phenomena, and which is confirmed by experience, leads us to expect similar facts in the future. Our confidence being justified, the rule is verified.

But there is room for more, possibly for higher, i. e., more general laws in nature, which may or may not be discovered hereafter. These cannot contradict those already discovered, though in particular application they may appear to contravene the laws already known, by counteracting their results.

(3) It is our *mind*, then, which discovers an underlying unity, an "order of nature," and presumes it where it is not yet proved. This, also, must be deemed to be objectively rational, or the product of intelligence. For what reason discovers is itself rational; our reason connects the phenomena, not arbitrarily, but because of a rational order in them.

(4) Furthermore, such unity, such order, such connection of antecedent and consequent, such mechanical conjunction of parts, such continuity of force (whatever that may be), seen to be always changing in application, but so far as we can discover, always equal in amount; these, on which are based the highest laws of physics, are so invariable that the mind cannot conceive them to be otherwise. We must assume them to be established principles in the existing order of facts. One in old times who believed the facts to proceed from a spiritual source, without any scientific theory of the conservation of energy, said: "With Him is no variableness, neither shadow of turning." And another said: "He hath given them a law which cannot be broken."

(5) A new fact presented to our senses, or duly vouched for, if not explicable by known laws, is not to be rejected. It may hastily be assumed to contradict a law or the order of nature, when, in truth, it is merely incapable of being referred to any known combination of forces. The facts related in connection with what is called "spiritualism," if they were duly attested, would furnish a very striking illustration of this scientific principle.

Contradiction properly applies to universal principles of reason, not to limited empirical rules which may be, and which are, contravened by others. A cause operating with no effect is a contradiction in thought and in words. So is an effect without any adequate cause. But the contradiction is not empirical; for in experience we see apparent failure, and similar effects following upon various antecedents.

(6) I assume, also, as a postulate the existence of spiritual substances, human and superhuman, which are capable of modifying material phenomena, through combinations of what are called material forces (whatever these may be), if not otherwise. (It is possible, indeed, that that purely metaphysical notion called "force," is the sensible operation of that unknown substance called "spirit.")

Natural science may say that the existence of spiritual beings is not proved, not even the existence of spiritual substance called *ego* in man. But neither is their existence disproved, nor can it be. The utmost that positivism can assert, is that their existence is beyond the reach of investigation and knowledge. But since this postulate is not unscientific, contradicts no known principle of nature and reason, and simply begs the *existence* of such beings without a knowledge of their nature, which latter is what positivists dispute, I have a right to employ it as a hypothesis, and this is all that I require, in proving that wonders in ancient or modern times are not antecedently incredible, nor to be rejected as contradicting what we know.[1]

---

[1] But I ought to add that this postulate of a free spirit implies that its actions and its laws, even if they can be emperically known, do not strictly come under the province of scientific phenomenal induction, where all seems to be necessitated, and every antecedent to have its invariable conse-

II.

These postulates being premised, I would at once remark that it may be, indeed, possible for the believer in a Creator and Ruler of the world to suppose his immediate interference in the empirical order of the phenomena, his special operation without the empirical antecedents which we ordinarily see in nature. I have nothing to do with that explanation of what are called "miracles." I only remark that the question is then altogether removed from the sphere of science, and no reconciliation, I think, is to be sought for. As a thoughtful scientist once said to me, "I keep my faith in one pocket, my science in another, for I find it necessary to keep them apart." It seems to me strange that truths should be in such an awkward position, especially if any one have reason to believe that empirical laws are the operation of an unseen Ruler of the universe teaching us the invisible things which we could not otherwise comprehend.

But, dismissing the question as not before us, I fail to find in any of the facts, commonly received as true, any need of such a divorce from science. It is now generally admitted, and has been admitted by careful thinkers in past ages also, that nothing occurs *contrary to the order of nature.* I may refer to former believers in what are called "miracles," because they would be likely to deny it if any philosophers did. But Augustine[1] and Thomas Aquinas[2] argue that nothing can happen contrary to the order of nature; for, they say, nature is the product of an unseen Being who can not contradict himself. So I suppose we may hold this as practically undisputed. But the proposition contains a term which calls for definition.

In common acceptation "nature" seems to signify:

(1) The sensible phenomena which we group under the name of matter.

---

quent. I grant, however, that we cannot conceive of contradiction between these two, sc., the freedom of spirit and the necessity of nature, or of any violation of empirical laws. I cannot stop to discuss this inference from my sixth postulate; but we must have some common ground to stand on and to start from; I ask for this.

[1] S. Aug. contra Faust., XXVI, 3; XXIX, 2.

[2] Sum. Theol., I, 105–6.

(2) The forces which our mind discovers to be working changes in these phenomena.

(3) The intelligence which our mind also discovers in the unity, order and adaptation of these phenomena when viewed as a whole consisting of parts infinite in number and variety.

Force may be only the operation of an intelligent cause, and so the two latter may be regarded as due to the influence of a spiritual being working in the sensible world. In the *potentiality* of material things are these sensible results, and possibly more which is now inconceivable, but active intelligence may be needed, as Aristotle long ago pointed out, to produce these results. If we thus define nature, when most unusual and marvelous facts are related to us by eye-witnesses, there are various possible hypotheses :

(1) They are brought about by some one whose extraordinary insight into nature's laws places him far in advance of his age, and enables him to produce results which even now we cannot explain ; just as if, one hundred years ago, a man in New York had related an audible conversation held with another in San Francisco.

(2) The deeds were superhuman, though not supernatural in any other sense of the word, *i. e.*, according to my sixth postulate, they were such as spiritual beings of a higher order than man may accomplish within the order of nature. Forces, as they are called, were combined to produce results which we may never be able to reach. For example, man can only affect nature, so far as we now know, through his own organism ; but there is no antecedent impossibility in the thought of spiritual beings of a higher order having a wider sphere of influence.

(3) The deeds are "*supernatural.*" But here again we meet with an equivocal term. The supernatural, as Kant points out in his "*Beweisgrund zu einer Demonstration des Daseyns Gottes*" (1763), may be, (*a*) added qualities, properties or forces (which, for our purpose, are one), imparted to substances already in existence.

I have never heard any reason why science and philosophy should pronounce this *a priori* impossible, although it is certainly very improbable, and perhaps removes a fact, however well attested, from scientific thought or investigation. For modern

physics seem to show that it would involve a modification of the whole universe, viewed as a mechanism of mechanically conjoined parts, which is very hard to receive.

(*b*) The supernatural means an increment or diminution of some existing force in its relations to others, as if a man were suspended in the air or walked on the water, through his being specifically lighter than he was before; or as if, which as one theologian of high repute asserts,[1] babies are lighter when awake than asleep, through the influence of their spirit.

This also, I think, cannot be pronounced *a priori* impossible, though the difficulty is the same as before.

(*c*) There is what Kant calls the "formally" supernatural, where qualities, properties, or forces remaining unchanged, the method, connection or intelligible bearing, and consequent result, of existing forces, are different from what the laws of material nature, by themselves, would produce. Here, of course, we are carried back to the first and second hypothesis concerning marvelous events, sc., that they are the effects of the action of man's spirit, or some other spirit, upon the phenomenal world. But here we view the free spirit operating upon nature (which is not free), as from without and from above. It may be the finite spirit making use of powers supplied by the infinite one, as when the free will of man introduces supernatural results into nature by freely combining agents, bringing forces into special application and producing intelligible results. We are so familiar with these that we do not ordinarily call them supernatural, since in common application the word may mean almost anything that is extremely unfamiliar and wonderful; and yet these results may be widely different from anything which nature itself would have produced. Such are, the mule among beasts, the gardener's flowers, the diverted water-courses, the rough made smooth, the crooked straight, the high places laid low, and rock and swamp made to bloom like Dante's terrestrial Paradise.

If, then, any one find it not unscientific or unphilosophic to recognize a conscious being of infinite wisdom, it will not be unscien-

---

[1] The present (1880) Archbishop of Dublin.

tific or unphilosophic to assume the possibility of his doing, on a limitless scale, what we do on the smallest, without altering, any more than we do, one law, force, property, or attribute which, on that theory, has been his own perpetual working from the beginning of the world.

(4) Lastly, the supernatural, as a notion of our minds, might mean that which I, for my part, would be inclined to regard as a purely negative notion, and no positive thought at all, viz.: what follows no law of material nature, but is an immediate operation of a supreme being, without material antecedents or any medium whatsoever. This is what Spinoza discussed as an interruption of the order of nature, and tried to show to be impossible.

Returning to the formally supernatural, I may observe that it finds its rational harmony and unity with the natural; first, because, as stated, the forces, attributes or properties of things remain unchanged; secondly, because the adaptations, ends and moral relations of things are similar. I mean that man, by his free spirit, does similar things to what nature does. Whether this remark apply to neo-platonist wonders of old, and spiritualist wonders of recent days, I will not inquire. But I remember that one who, as Sir William Hamilton says, would have been the greatest of philosophers had he not been greatest in another sphere, notices that the historical wonders recorded in the christian sacred books are strictly analogous to those which are always produced.[1] And this remark will illustrate my meaning to any one who admits adaptations, ends, and moral relations as existing in the present order of nature.

Consider, e. g., an earthquake or the Chicago fire. The phenomenal sequence can be investigated according to known laws. It proves to be a chain of a number of links practically infinite. The intelligible or moral end, if such exist, does not come under the province of phenomenal induction. If it exist, it may be sought for, but by the aid of suitable principles, not by scientific induction.

A man may know in himself, in his own conscious life, moral

---

[1] S. Aug. de Trin, III. 5.

results from a fire or from illness. He may discover these in the history of a community, as he does again when that community, accumulating wealth, becomes dissolute and luxurious, which is a moral consequence from physical antecedents (not necessary, like physical sequences); or, by war, is reduced to poverty, with certain other moral results.

When we look merely at the scientific sequence of phenomena these results may be said to be accidental, or contingent, but there they are, and the explanation of them involves the prior question whether, as some of the ancient philosophers agreed, there is an intelligent providence in nature, adapting physical consequents to moral results.

Our search for a definition of the supernatural has landed us in the *providential*, which latter is surely an admissible scientific hypothesis. And what does the supernatural add? Or is the providential itself supernatural, as something *superadded*, upon nature, and *vice versa*, except that a certain element of unusualness is added? The answer must be deferred. But let us observe that if the providential is not in nature, *cadit quæstio*. If it be present, we may call all this moral adaptation supernatural, as not directly implied in the physical laws, nor capable of reduction under them.

III.

Proceeding now to the proof of my main proposition. I rest it on the following principles:

(1) *Appearances or events*, no matter what they may be, common or most rare and strange, *may have various antecedents, known or unknown.* Science proceeds with sure steps from antecedent to consequent. For each cause has some certain invariable effects. But it is otherwise in going back from observed results. We must assume physical antecedents, or rather, combinations of them, we are never absolutely certain what they are. Various causes, infinite combinations of them, may produce a given effect. For example, the so-called "diluvial scratches" are now referred to the action of glaciers. An antecedent is found to have existed, a sufficient one, but a different one from what was assigned only

a few years ago. It is adopted as a working hypothesis, and it answers every purpose; but it is liable to be replaced by other antecedents, as it has itself replaced the theory of deluges. The raising of a body in the air, or its resting on the surface of water may be due, not to a suspension of the law of gravitation, or to a change in the specific gravity of elements, but to the unknown attractive or repulsive force called magnetism, to other unknown forces, or even, conceivably and within the potentialities of matter, to the influence of a spiritual substance on that body, which latter would not be, any more than the former, a suspension of nature's law, or an interference in nature's sequences, which might go on as usual. The attested fact must be tested as others are, by the rules of testimony; it must not on *a priori* grounds, at least, be rejected. Experience informs us of the frequent fact of spirit influencing matter, while the same experience points to an unbroken chain of physical antecedents. What, then, may not a more powerful spirit, if it exists, effect upon that purely potential and passive thing called matter? What unimagined and unimaginable powers, lying dormant in it, may not be awaked by the energetic touch of vivifying spirit?

All this may be called wilful fancy, not based on experience, and not *verifiable* by repeated experiment. To which I reply, that the asserted event is itself a fact of experience narrated by witnesses, while the verification, the repetition of it, supposes that we are able, (1) to *explain* the event by giving all the antecedents, and so (2) to reproduce or find them, which is precisely what we may be unable to do. In this case we may not know by observation, but will certainly have no warrant for rejecting the observation of other men. In fact we are obliged, in thousands of cases, to rest contented with the observations of other men, and may have no hesitation in doing so, even if only one man has observed the fact, and we think we can trust him.[1]

---

[1] I know a scientist of many years' experience, who tried to verify certain reported observations on "vortex-rings," and saw hundreds of experiments give a different result. He did not dispute the asserted fact, but, I suppose, assumed, rather, that the antecedents in his experiments were different and produced a different result.

The verifications now before us do not, indeed, suppose a costly apparatus, excessively difficult experiments, with results requiring most delicate powers of observation. Or if the question lay between different hypotheses in accounting for the same fact, examination by scientific experts might be deemed a *sine qua non.* But the facts submitted to us by testimony are simply observations of our senses in which all men are equal; while on the other hand the fact that free spirit is concerned, and moral conditions therefore requisite, may make the coincidence of antecedents excessively rare, while yet the results, when they do occur, will be patent to every man of common sense who has the eyes and ears that belong to the whole human race. Repeated failures of "spiritualists," therefore, cannot negative any well-attested observation, if it be justly deemed above suspicion.

(2) In the second place, *inductive science ascends along a chain of physical antecedents which is, practically, of an infinite number of links, and which has no place for mind anywhere in the series.* Its end is never reached, possibly, never can be reached; if, indeed, it should not eventually be found to be a circular chain, which consequently has no end at all.

But mind, if you grant its existence, is known to modify results, without entering as one link in this chain. The very freedom of mind renders it impossible that it should so enter. *How* this can be no one, I believe, has thus far explained. The fact is one of observation. You may, observing my body as an object external to yourself, see the motion of my finger, and then proceed inductively to contraction of the muscles which you cannot see, to nerve-power, brain stimulus, nutrition of brain, blood, chyle, bread and beef, grass and carbonic acid,— equal energy in all these — and you may end no one knows where. You cannot insert mind anywhere in that chain, nor find physical force augmented or diminished by it. You cannot know what I know in my own consciousness, that I freely willed to move my finger. If there is no such thing as free mind, *cadit quæstio* once more; but it was my postulate.

I am not concerned with the explanation of the apparent paradox, nor with the question which Kant asks and thinks that

he answers, "whether an effect determined according to nature's laws can at the same time be produced by a free agent?" But there is the fact, mind modifies the force or energy in bread and beef for a new and sensible result. Similar modifications, therefore, are possible elsewhere.

I will take another example, and one which will illustrate other propositions of mine beside the one immediately before us. A man receives a letter or reads an article in the newspaper, and then sends a bullet into the breast of the man who wrote the words. Physical science calculates the force of the bullet, of the powder, of the spring of the pistol, of the finger, of the brain, as we may suppose, and so on. But the *reading of that letter* was an act of mind: and mind supplied the motive for the act, but the motive adds nothing whatever to the physical force. There is nothing in mind which can be inserted into the chain of physical antecedents. Motives, like moral results, belong to another science, having its own laws, which do not interfere at all with those of natural science, although physical results are modified in the most remarkable manner.

(3) Thirdly, my argument compels me to note that the narrators of the marvels to which I have referred have no occasion to offer any theory concerning these results, or, if they do offer one, we are not concerned with that in our question of the *a priori* credibility of the facts. Mr. Crooke's mode of accounting for "spiritual" phenomena is quite another matter. One narrative puts the subject on its proper footing where a man says, "One thing I know, that whereas I was blind, now I see." The only theory, so far as I know, which the narrators offer in the Christian sacred books, is that of the moral end and bearing of the events which they describe, or what we find also in much Greek philosophy, and may call the *providential* character of the events, which, of course, would not essentially distinguish them from ordinary occurrences. But with this, science, as such, has nothing to do.

I have only occasion to refer to it as illustrating my proposition that witnesses of wonderful events can only give us their sensible impressions. For example, dwelling on this providential character of events, going back, therefore, to the first cause, and leaving

out of view all physical antecedents because the writer was not interested in them, one says that a free spirit sends the rain, and makes the wind blow; but, on special occasions, a man is said to have prayed and the rain came; and the east wind is said to have driven back the waters of the sea at the head of the gulf, so that fugitives might pass. What preceded in the chain of physical sequences the narrator does not pretend to say, because he is not a scientist. If we infer that he meant that there were no antecedents, and so dispute his narrative on *a priori* grounds, we are putting our own inferences into what he says. Some people have regarded nature as a machine moving on of itself, and, occasionally, not doing all that it ought; whereupon the maker of it steps in and adjusts it for a special work. And while this seems to be irrational, we read historical statements by the light of this pretended explanation, and judge them accordingly. There is not the slightest evidence that the observers of the events had their vision clouded by any such hypothesis, as a man might go to see what some scientists have described as "spiritual manifestations," with his mind made up in advance, and, consequently be not a clear-headed and clear-sighted observer of what was under his nose.

In a simpler age, without any scientific theory, the historian may relate both familiar and strange events with the same direct reference to the primary, efficient and final cause, and none at all to physical antecedents. The antecedents of the Chicago fire are known; its moral bearings, if it have any, are matters of inference and analogy. But the antecedents of the destruction of the fertile plains on the lower Jordan where the Dead Sea now lies one thousand, three hundred feet below the Mediterranean, are not known, and the ancient narrator, whoever he was, takes the liveliest interest in its moral bearings. But, if his narrative be otherwise credible, we are not obliged to assume that he said that physical antecedents were not in their place, and so reject his story on that account.

IV.

But it may be said that these are *natural* events, while others which are narrated in the same manner are *unnatural* and therefore impossible. Such, *e. g.*, it may be said, are some of the "spiritualist" wonders, or the "miracles" at Knock, in Ireland, or, again, the story that the touch of a man's hand, or even his shadow, cured the sick. Here, it may be said, is no "natural" connection of antecedent and consequent. But it would be well to define precisely what we mean by "unnatural." (1) It cannot very well mean what is incapable of explanation. For no one explains how quinine cures malarial fever; yet one does not, on that account, call the cure unnatural. (2) It cannot mean an effect which is without any physical antecedent, for physical antecedents, such as a shadow or a touch, may chance to have been observed in very marvelous cases, like those just referred to. (3) It ought not to mean a violation of nature's laws, for that would be begging the question which is the very subject of our discussion. "Unnatural," therefore, can only mean very unfamiliar, and that the particular antecedent mentioned, if we see it repeated *under other circumstances*, is not followed by the same effect. A most unscientific mode of thought, even if the best of scientists fall into it. A scientific treatise, indeed, ought to give all the antecedents; an unscientific observer mentions only what he happens to see, though his narrative may imply many other antecedents, as the ordinary stories of spiritualists, and those which I have just referred to actually do imply. I suppose that shadows are not ordinarily followed by marvelous cures; and so, without any reference to scientific principles, there is an inward persuasion that there was no connection between the antecedent and the consequent, and the alleged event is pronounced "unnatural," or else the attempt is made to refer it to some known law, as if the measure of our knowledge were the measure of all existing laws. But let an impartial inquirer supply, if he can, all the antecedents, not only physical, but moral and spiritual, before he decides that such a narrative is *a priori* impossible.

And he ought not to object to the introduction of moral and

spiritual elements as modifying the physical chain to which they do not belong, since he probably knows consequents from bread pills and Dr. Beddoes' cure of paralysis by a thermometer placed under the tongue, and, conversely, that the state of the soul will arrest the process of physical antecedent to physical consequent, so that medicine fails, as we say, to have its usual effect. And yet it would seem improper to call this unnatural, or a violation of nature's laws.

The arresting of processes of dissolution and of the passage of elements into new forms, followed by the rising again of the dead, would be a most startling occurrence. We cannot easily, if at all, imagine its antecedent. But the appearance of a new, intelligent being in the physical universe (if my sixth postulate be granted), is equally so. But we do not speak of a suspension of laws or an "*interposition*" of the first cause in this case. There are known physical antecedents so far and so far only as the new-born child belongs to the physical universe. But no explanation of the sequence which results in an intelligent human being can be given. In the other case also, if well attested, will be physical circumstances excessively rare; conditions which put verification out of the question. The fact, if received, is to be received on other grounds than those of physical science; but the latter has no valid objection to present. I might bring forward an analogy, of course, a feeble one, but a supposable case. Let us suppose the galvanic current applied to a nerve still sensitive, in a body which has lost its general life. A new combination of physical antecedents produces a result which is entirely new and startling. But the order of nature is not suspended, although only a few persons can verify the fact by renewing the same conditions. So also it is at least *conceivable* (and that is all that I require) that a spiritual power, granting its existence (my sixth postulate), should preserve that sensitiveness in a body called dead, and subsequently restore to it its soul. The latter is a substance known only by its recognizable phenomena, by its operations in, on and through the bodily organs. The body then will resume its normal functions. The man will live again. There I

fail to see any suspension of nature's physical chain of sequences. Science, then, must relegate the fact, if a dead man is revived, to what Bacon calls "instantiæ monodicæ, "or "heteroclitæ," or "irregulares;" not that they obey no rule, belong to no species, but, for the present, they stand alone.

In fact, this perhaps will be one of the fruits of startling discoveries in science, that our limited notions of the potentialities of the world will be enlarged. Most grossly improbable as it was, it was hardly received with suspicion by the majority, not very long ago, that a human being could be thrown into a stupor for a century and then revived. "There are more things in heaven and earth than are dreamed of in your philosophy."

As a test and illustration of these principles, I will take, because it happens to be found in a narrative tolerably well known, the assertion that three men were put into a fiery furnace, and not burned. It is a severe test, because we cannot imagine any antecedents, and that which is said to have been there, the intense heat, seems to have had no consequent in the case of these three men; which, by itself, is inconceivable.

But observe that the existence of another spiritual being in sensible form is attested by the writer. Now, as one man works a seeming miracle by substitituting electric currents for waves of sound, so it is certainly conceivable that another freely acting agent should modify or turn back ethereal waves of heat in an unknown manner, secure admission of air, etc., by media absolutely unknown to us, but the order and chain of nature remaining precisely what they are, and, so far as we know, always have been.

Much as the problem transcends our present knowledge, I do not know what is unscientific in the hypothesis, or why, if duly attested, the fact should not be referred to Bacon's "instantiæ monodicæ."

Here I must conclude. I have endeavored to avoid theological questions, and to confine myself to a philosophical and scientific view. This, only, I would ask leave to add, with respect to the presumed controversy between Christian faith and physical sci-

ences, of which so much has been said, that, so far as I know, and I have examined the matter carefully, the positions I have laid down do not essentially differ from those of that great philosopher of the fifth century to whom Sir William Hamilton refers as one of the greatest lights in the world of thought, who did his work so long before physical sciences took their present stand, and who has done more also than any other one man to formulate the faith of western Christendom. For this two-fold reason, I beg leave to refer to him. S. Augustine offers no theory of the "preternatural." The alternatives which he recognizes are, according to nature, and against it. The latter may be our mode of describing such facts as do not seem to follow such laws as we know. But nothing can occur against nature's highest laws, for that would be against the first great Cause. He speaks of daily miracles, i. e., operations of unknown causes, and these are events (e. g., he mentions the wind and rain) which, if unfamiliar, he says, would as certainly be called miracles as any which bear the name, and yet we know that science is busy in tracing their physical antecedents with fair success. S. Augustine accordingly finds the special character of certain events in what he supposes to be the known moral end and bearing of them, not in an "interference," so called, of the worker in and through nature.

Finally, I can only say that it is not my aim to offer my hypothesis as the correct explanation of certain events, among the many marvelous records of history, which are recorded in books held by some of us to be inspired. I have simply taken up a problem of philosophy and science, and endeavored to analyze it in the light of well established principles, and to show that there is no *a priori* ground in science or philosophy for rejecting any such facts. Further than this I do not desire to go.

If I am not mistaken Mr. Huxley has taken some such position. His reasons I do not know.

I will add also, since Mr. Kinnear's paper in the *Contemporary Review* for December, 1879, traverses in part the same ground with mine, that what I have just submitted to the Academy was completed before that number of the *Review* appeared. The fact

may increase the probability that the views now presented have some rational foundation, or at least some claim to candid consideration.[1]

---

[1] Dr. Bushnell [Nature and Supernatural], indeed, going by a similar route, arrives at the same conclusion; but without defining, he assumes the existence of a personal Being, God, which for the purpose of my argument is not necessary. I have had occasion to examine his work, however, only since this paper was submitted to the Academy.

FIRST FRENCH FOOT-PRINTS BEYOND THE LAKES; OR, WHAT BROUGHT THE FRENCH SO EARLY INTO THE NORTHWEST?

By JAMES D. BUTLER, LL. D.

Copper mines in the north, and burial-barrows everywhere, bespeak prehistoric races in Wisconsin. But in *modern* Wisconsin there was little agricultural settlement before 1836, which we may accordingly reckon its American birth year.

Between these two developments, however, there was a third, a sort of midway station between the mound-builder or the Indian and the Anglo-Saxon — namely, the *French* period. This portion of our annals seems worthy of more attention than it has yet received.

The French were early on Lake Huron, and even in Wisconsin. They were there before the cavaliers in Virginia, the Dutch at Albany, and the Puritans of Boston had pushed inland much more than a day's journey. The Mississippi was mapped before the Ohio. Champlain sailed on Lake Huron in 1615, only seven years after the settlement of Quebec. A monk had arrived there a month or two before Champlain.

On early maps the contrast between French knowledge and English ignorance is at once plain to the eye. On the map drawn by Champlain, in 1632, we see the Lakes which we call Ontario, Huron, Superior and Michigan, while no one of them, nor indeed any river St. Lawrence, is discoverable on Peter Heylin's atlas, the one best known in London twenty years afterward. On the blank, where those inland seas should have figured, we read the words *America Mexicana*, as if Mexico had extended to Hudson's Bay.

But while the English on the Atlantic coast were ignorant of western geography, and before the French in Canada numbered ten thousand, Joliet and Marquette, in 1673, traversed Wisconsin from lake to river. They were long supposed to be among the earliest explorers of Wisconsin. In 1853, however, the Catholic

historian, J. G. Shea, pointed out in a volume of Jesuit *Relations* the following words, written from Quebec to France, in 1640, by Father Le Jeune: "M. Nicollet, who has penetrated into the most distant regions, has assured me that if he had pushed on three days longer down a great river which issues from the second lake of the Hurons (evidently meaning Lake Michigan), he would have found the sea."

The word *Mississippi*, meaning "great water," was ambiguous, and, though really denoting a river, might well be mistaken for a sea, especially by an adventurer who knew the sea to be in that direction, and who believed it by no means remote.

On the strength of this Jesuit testimony, Parkman remarks: "As early as 1639, Nicollet ascended the Green Bay of Lake Michigan and crossed to the waters of the Mississippi." This was within nine years after the founding of Boston, which claims to be of all northern cities the most ancient.

But in the lowest deep a lower deep still opens. According to the latest researches of Benjamin Sulte, Nicollet was in Wisconsin four or five years earlier than 1639. He started west from Canada in 1634, and returned the year following. The best Canadian investigators assure us that he never traveled west again, but, marrying and becoming interpreter at Three Rivers, below Montreal, he remained there or thereabouts thenceforward till his death. All agree that Nicollet visited Wisconsin. If it is proved that he was not here in 1639 or afterward, he must have been here before. There is some reason for holding that Nicollet had penetrated into Wisconsin at a date still earlier than 1634.

Chicago is not known to have been visited by any European before 1673. In the autumn of that year Marquette, returning from his voyage down the Mississippi, was conducted from the Illinois river by Indians to that spot as affording the shortest portage to Lake Michigan. The next year that missionary, on a coasting tour along the lake, after a voyage of forty-one days from Green Bay, reached Chicago,— which was then uninhabited. As sickness disabled him from going further, his Indian oarsman built him a hut, and two French traders who already had a post a few leagues inland, ministered to him till the next spring, when

he so far recovered as to proceed to St. Joseph. Another Jesuit was also met at Chicago by four score warriors of the Illinois tribe in 1676.

Three years afterward, in 1679, La Salle found no inhabitants there. On his map made the next year he described it as a portage of only a thousand paces, yet thought it in no way suited for communication between the lake and Illinois river, as the latter at low water was for forty leagues not navigable. Within two years after that, however, in 1681, he preferred this route for his own passage. On the sixteenth of December starting from Chicago with canoes on sleds, he arrived at the mouth of the Mississippi in one hundred and seven days,— that is on the sixth of the following April.

The Chicago portage was traversed by Tonty, La Salle's most trusted and trust-worthy lieutenant, June, 1683, and by Durantye in 1685. La Salle's brother detained there in 1688 by a storm, made maple sugar, and in one hundred and ten days after leaving its harbor, had made his way to Montreal.

After eleven years more, St. Cosme found a house of the Jesuits there established, at which, as at a sort of post office, Father Gravier obtained in 1700, letters from Paris. From that point La Salle had written a letter to La Barre, Governor of Canada, in 1683, and in the map by Franquelin, royal hydrographer at Quebec, dated 1684, eighty houses,— meaning wigwams, are set down on the site of Chicago. It was then viewed as a northern out post of La Salle's central castle — the Rock of St. Louis,— that marvellous natural fortress which the French explorer found ready to his hand,— "his wish exactly to his heart's desire," now called *Starved Rock*, near the confluence of the Big Vermilion with the Illinois river, a few miles west of Ottawa.

All the way down from this era of La Salle the French as rovers, traders, settlers, soldiers and missionaries in our Northwest, are traceable generation after generation. The chain is as unbroken as that of apostolical succession has ever been fancied.

How shall we account for the phenomenon I have now sketched, that the French penetrated so far inland so early and so persistently? My answer to this question is implied in the words Fun, Faith, Fur, False Fancies, Finesse and Feudalism.

Nicollet, it is admitted, was west of Lake Michigan before La Salle was born. What brought him thus early into the heart of the continent?

My answer is that he came for sport; yes, just for the fun of the thing — or the romance and exhilaration of adventure.

Where is the community in which it is not proverbial to this day that worlds of fun lie in camping? What amount of civilization can kill off love for a feast of tabernacles, or relish for camp-meetings? What boy reads Robinson Crusoe without a passion to run away? Hunting, fishing, boating, discovering new lakes and streams, new varieties of woodland and opening, attacking or eluding antagonists — whether men or beasts — fire, frost, flood, famine: "foemen worthy of their steel," for what man that is young, strong and brave, must not these excitements have charms? When will the English give up their Alpine club? In France no man was more of a sportsman than the King, Louis XIV, and in his era especially, French country gentlemen spent most of their time hunting and fishing. Accordingly for the French those pursuits had dignified associations. The first French party that ever wintered on the shore of Lake Erie thus wrote home, more than two centuries ago: "We were in a terrestrial paradise. Fish and beaver abounded. We saw more than a hundred roebucks in a single band, and half as many fawns. Bear's meat was more savory than any pork in France. We dried or buccaned the meat of the nine largest. The grapes were as large and sweet as any at home. We even made wine. No lack of prunes, chestnuts and *lotus* fruit all the autumn. None of us were homesick for Montreal." Far west was the happy hunting ground of Indian fable. There too the French found it in fact.

The late Judge Baird of Green Bay used to describe as the happiest three weeks of his life, the time when, taking his family and friends, with a crew of Indian oarsmen, he voyaged in a bark canoe from our great lake to our great river, along the track of Joliet and Marquette. Every day the ladies gathered flowers as fair as Proserpine plucked in the field of Enna, while the men were never without success as fishers and hunters. They camped, usually early in the afternoon, wherever inclination was attracted by natural beauty or romantic appearance. After feasting on

venison, fish and wild-fowl, they slept beside plashing waters till roused by morning birds. At every turn in the rivers, new scenery opened upon them. Overhanging groves, oak openings, prairies, rapids, Baraboo bluffs, outcrops of rock, ravines, mouths of branches, each was a pleasant surprise. That merry month of May, 1830, recalled to the voyager, in the long lapse from youth to age, no other like itself. How many would give half their lives for such a wild-wood memory!

In the light of such an experience, it is easy to see how Nicollet was drawn on and on into the unknown west. No wonder that, only ten years after Quebec was occupied, we find him, in 1618, wintering half-way from that new-born post to Lake Huron, in the Isle of Allumette. He had no longing for the security of dwellers beneath the guns of Quebec. Amid his perils he despised them, as Caudle-lectured husbands despise those couples who vegetate together for years without a cross word, but in such a stupid style that they never know they are born.

Nicollet was a representative of a *large element* among French Canadians. In 1609, at one of Champlain's first interviews with Indians from the remote interior, a young man of his company had boldly volunteered to join them on their homeward journey, and to winter among them. He remembered Pierre Gambie, a page of Laudonniere in Florida, who being allowed to go freely among the Indians, had become prime favorite with the chief of the island of Edelano, married his daughter, and in his absence reigned in his stead. Champlain's retainer was among the first of a class — up to everything, down to everything — who "followed the Indians in their roamings, grew familiar with their language, allied themselves with their women, became oracles in the camp and leaders on the war-path."

Their fun was as fast and furious as Tam O'Shanter's:

> "Kings may be great, but they were glorious,
> O'er all the ills of life victorious."

For them civilization was no longer either cold or hot — but so lukewarm that they spewed it out of their mouths. Something of their feeling burned in their best historian, Francis Parkman,

who exchanged Boston for the Black Hills before one miner had pushed into their fastnesses. His strongest youthful passion was to share in unaltered Indian life, and his loudest cry was: "Savagery, with all thy lacks I love thee still!"

Preference for Indian life has grown up even in *Yankee* captives, and, what is most surprising, in *females*.

A well-known instance was the daughter of Williams — the Massachusetts minister — who refused to be redeemed from captivity in a Canadian tribe. Some will suggest that having been brought up in a parsonage of grim and vinegar aspect, she thought nothing could be more repulsive than a Puritan strait-jacket. But many similar instances occurred during Bouquet's expedition west of the Ohio, which was undertaken in order to rescue whites from Indian bondage. Several women, and those not of ministerial families at all, when compelled to return to white settlements, soon made their escape to the woods, preferring wigwams to their native homes. No thrice-driven bed of down was so soft to them as a couch which, as their phrase was, had never been made up since the creation. Many captive *men*, when given up to Bouquet, and bound fast to prevent their escape, sat sullen and scowling that they were forced back into society.

In civilized society there was no sweet savor of romance for

> "A wild and wanton herd,
> Or race of youthful and unhandled colts."

No wonder, then, adventurers into the great west, who would rather be scalped at Mackinaw than live in Montreal, became a permanent class. No wonder when La Salle, first of white men, had burst into the heart of Illinois, six of his soldiers deserted, and that as many more of his little band had ran away in the far north. One of these last absconders was encountered by Hennepin in the wilds of Minnesota. Another in that region was a runaway from Hennepin himself. Nothing less than throwing themselves overboard from all social restraints could give scope for that superabundant vitality which philosophers hold is pre-eminently a French characteristic.

The roving class was all the larger, because settled colonists were *vassals*, both in soul and body. In Canada, individuals existed for the government, not the government for individuals.

Cooped up in the dull exile of petty forts, their prayer was that of the country mouse when entrapped in a city mansion —

> "O give me but a hollow tree,
> A crust of bread and liberty."

La Hontan — a young officer fresh from France — thus wrote home from Montreal: "A part of the winter I was hunting with the Algonquins, the rest of it I spent here very disagreeably. One can neither go on a pleasure party, nor play cards, nor visit the ladies, without the curé preaching about it; and masqueraders he excommunicates."

Other writers add that no dances were allowed in which both sexes took part.

Allowing dances to one sex only was about as satisfactory to gay and festive youth as a father confessor's permitting a fair penitent to rouge only one side of her face; or letting out an American lady to walk the Parisian boulevards only on condition that she never goes alone, never wears colors, and never looks into a shop window. Anti-dancing laws — it is needless to add,— were doubly vexatious to a Frenchman, since his feet when he's sleeping seem dreaming a dance.

Fathers who neglected to marry sons till they were twenty, or daughters till they were sixteen, were fined. Bachelors were barred out from the Indian trade, and even branded with marks of infamy.

In Quebec chronicles for 1671 we read that Paul Dupuy, having said that when the English cut off the head of Charles I. they did a good thing, the council declared him guilty of words tending to sedition, and condemned him to be led in his shirt, with a rope about his neck and a torch in his hand, from prison to the castle, there to ask pardon of the king; to be branded on the cheek, set in stocks, laid in irons, etc.

At the same period Louis Gaboury, charged with eating meat in Lent, was sentenced to be tied three hours to a stake, and then

on his knees to ask pardon at the door of the chapel. Swearers, for the sixth offense, had the upper lip cut with a hot iron, and if they still uttered oaths, had the tongue cut out altogether. Two men were shot at Quebec for selling brandy to Indians.

Not a few French immigrants had been *tramps* in the old world, and transportation to the new world gave them no new nature. The Bohemian element was in them as an instinct, and was as sure to come out by natural selection as ducklings hatched by a hen are to take to water. The Saint Lawrence flowed in one direction; the sinful loafers steered in quite another.

Other Canadians had been *convicts* and so would naturally regard all walls as stifling imprisonment. They were not a pious race, but one prayer they never forgot, namely: "From red-tape and ritualism, good Lord, deliver us!"

An order of Indian Knights sprung up — young men who thought nothing so fine as to go tricked out like Indians, and nothing so attractive as Indian life; doing nothing, caring for nothing, following every inclination, and getting out of the way of all correction. This club may have been a natural reaction from a society of matrons and maidens established to promote gossip pure and simple. Meetings were held every Thursday at which each member was bound by a gospel oath to confess — not his own sins, but other people's — that is, all she knew, alike good and bad, regarding her acquaintance.

There is a *physical* reason why those who have learned to live in the open air cannot live in houses. Sleeping under roofs they exchange oxygen for miasma.

The Circassian mountain chief, Schamyl, when a Russian prisoner, was luxuriously housed, but at the end of a week told his keepers he must commit suicide unless they would allow him to lodge *above* the roof instead of under it. So, too, our Texan hero, Sam Houston, when, after open air campaigns, he entered the hall of congress, compared himself to a mouse under an air pump.

> "Yes, there is sweetness in the prairie air,
> And life that bloated ease can never hope to share."

During several years of frontier life, I have constantly fallen in with frontier men, who hover in the wilderness beyond the utmost verge of settlement. Villages, or at least ranchmen, follow them but only, as Paddy prays the blessing of the Lord may follow his enemies all the days of their lives — that is, so as never to *overtake* them at all. Change of base and new departures are as familiar to them as to any politician. The only grain they ever sow is *wild oats.*

The French found more fun in woodcraft than the *English* could. The one could thrive where the other would starve. It is an old saying that a French cook will make more out of the *shadow* of a chicken than an English one can of its substance. When a French army, near Salamanca, was cut off from supplies for a week by Wellington, he thought it a miracle that they did not surrender. The truth was that they had subsisted all the while on acorns. For more than a week Nicollet's only food was bark, seasoned with bits of the moss which the Canadians named *rock-tripe.* But he was not starved out. The Roman empire spread widely east and west, but never very far north. The fact is strange. To account for it, some say that Roman noses were too long, and so were nipped off by Jack Frost. The French are a snub-nosed race and so could better brave blizzards.

There is a strange *elation* when we discover with how many so-called necessaries we can dispense, and while having nothing, yet possess all things which we absolutely need. Detecting new capabilities, whether of daring doing or enduring, we seem to become new beings and of a higher order. We discover new Americas within ourselves.

According to the Greek sage, he is nearest the Gods who has fewest wants. In proportion, then, as we become self-sufficing, we approximate to the Gods. Not without exultation did the adventurer learn to make all things of bark — not only baskets, dishes, boats and beds, but houses and food. Every *tree*, when he perceived its bark to be rougher and thicker on the north side,— became for him a compass-plant. In his whole manner of life "the forester gained," says Parkman, "a self-sustaining energy, as well as powers of action and perception before unthought of,—

a subtlety of sense more akin to the instinct of brutes than to human reason. He could approach like a fox, attack like a lion, vanish like a bird."

The Homeric and earliest ideal of an adventurer, single-handed, into unknown regions, was Ulysses. It is true he goes grumbling all through the Odyssey,—but for all that he is happier to the very core than he could be with Circe or Calypso in any castle of Indolence. He thrives under evil, and at every new stage of his wanderings has new greatness thrust upon him. More than this: According to Dante, who met him in the Inferno, he soon tired of the Ithacan home he had sought so earnestly, and quitted it for enterprises more distant and perilous than ever.

Many of the early French pushed westward in pilgrimages longer and more varied than that of the most wide-wandering Greek. Their motto was:

> "No pent-up citadel contracts our powers,
> But the whole boundless continent is ours."

They pushed into the heart of the continent faster and farther, thanks to matchless highways,—I mean rivers and lakes,—styled by their wisest contemporary, Pascal, "roads which *march* and carry us whithersoever we wish to go." Thanks also to bark canoes, they flew as on the wings of eagles into the recesses of the west. When wishing to traverse Indian routes they had sense enough to avail themselves of Indian *boats*, doing in Rome as Romans do. For nine dollars worth of goods the voyageurs bought a bark twenty feet by two that would last six years. It would carry four men and more than their weight in baggage, yet was not too heavy for *one* man to carry across the portage between river and river, or round rapids which no boat could climb. Hennepin's bark weighed only fifty pounds. At night or in rains it was a better shelter than a tent. Thus the boatman was as independent as a soldier would be who could carry on his shoulders not only his horse and baggage, but also his barracks. Previous to the year 1673, no boat of *wood* had ever ascended above Montreal. The bark canoe of Judge Baird, of which I have spoken, was on a larger scale — about thirty feet long and five broad. It carried thirteen people and all their needments with ease.

Year after year La Salle risked life and lost fortune laboring to build a forty ton vessel for descending the Mississippi. After heart-breaking failures he trusted himself to a native canoe, and thanks to this new departure, easily gained the goal of his ambition. Had he found the great river hedged up by Niagaras — as was reported by natives — his progress would not have been stopped. He could have carried his boat till his boat could carry him.

A man who riding for the first time in a cab and asked where he was going answered, "To Glory!" spoke out the exultation which thrilled every French adventurer with his face set toward the western unknown, his hands skilled in paddling a bark canoe and himself encumbered with no more baggage than the shipwrecked rascal who said he had lost everything except his character.

Throughout the orient the name of *doctor* is a sesame open. When Moslems overhear a traveler addressed as doctor they unbar for him even their harems, no matter how often he tells them that it is only in law or divinity or farriery, that he is a doctor.

Among savages everywhere every civilized man passes in spite of himself for a physician. Relying on this reputation the early French ventured into the infinite west. Nor was their quackery less successful than that of an English monarch touching for the king's evil when

> "Strangely visited people
> All swollen and ulcerous, pitiful to the eye,
> The mere despair of surgery, he cures."

When Hennepin was a captive among the Sioux, whose blood had before been drawn only by the sucking mouths of medicine men, he bled their asthmatics, he treated other patients with a confection of hyacinth (a sort of squills) and desperate cases with *orvietum*, a theriac compounded of three score and four drugs. The more ingredients the more certain, as men thought, the cure, as the more bullets in a volley the more surely some of them will hit. A decade earlier, Perrot having dosed a surfeited glutton with the same theriac, had succeeded as well as the druggist, who, when *vox populi* was prescribed, gave *nux vomica*. The next

night Perrot was waked by chiefs who came for more theriac. His supply was so small that he only allowed them to hold their noses over the vial. The odor, however, proved a panacea. They beat their breasts and declared that it had made them immortal. For this sanitary smell they insisted on paying Perrot ten beaver-skins. They believed, what no doctor has been able to beat into Christian patients, that no medicine could do any good if it was not paid for.

These patients were Miamis. The Sauks, on the other hand, thought no medicine efficacious unless it was bestowed without money and without price. One of their tribe who had been badly scalded, declared himself cured the moment he was presented with a gratuitous plug of tobacco.

Relish for the romantic was a considerable element even in *missionary* zeal. Thus Hennepin admits that a passion for travel and a burning desire to visit strange lands had no small part in his own inclination for missions.

Again, many early bush-rangers belonged to that class who would rather reign in hell than serve in heaven. La Salle fell in with one tribe in mourning for the death of a chief, and he said: "Dry your tears! I will raise him from the dead. Whatever he was to wife, children or tribe, that I will be, feeding them and fighting for them. He is dead no longer." Thereupon he was hailed as chief.

Still others dashed among distant cannibals, in hopes, like Brigham Young among Mormons, to become Gods on earth. It paid for all privations to hear cringing Calibans cry out: "We pray thee be our God! We'll fish for thee; we'll kiss thy foot."

Saint Castine, who had nothing saintly but the name, roaming with Indians not far from the seaport in Maine which keeps his name in memory, gained such a supremacy that his aboriginal associates deemed him the prince of the power of the air.

In 1683, Perrot having built a fort near the outlet of Lake Pepin, paid a visit to the Sioux up the great river. He was placed by them on their car of state, which was a buffalo robe. He was thus lifted on high by a score of warriors, not like Sancho Panza tossed in a blanket, but borne as reverentially as the Pope

on his *sedia gestatoria*, or portable throne, into the house of council. There, holding a bowl of brandy which the Indians thought to be water, he set it on fire. He thus made them believe that he could at will burn up their lakes and rivers. A score of years before,—certainly as early as 1665,—he had become a potentate among Pottawatomies near Green Bay. Perrot was worshipped with clouds of incense from a hundred calumets, because he brought iron,—especially in the shape of guns and tomahawks. The further west he went the more unheard of his iron and powder, and the more they proved him a God.

One mode of reverence was to break off branches of trees and sweep the path his feet were about to tread. But the divine honors paid to Perrot were not always delightful. The Iowas, whom he pronounces the greatest weepers in the world, wept most effusively at his coming. Their welcome, he tells us, was bathing his face with their tears—"the effusions of their eyes, and alas! of their mouths and noses too!"

Other French adventurers threw up *rockets*, and thus record the sensation: "When the Indians saw the fireworks in the air and the stars fall from heaven, the women and children began to fly, and the most courageous of the men to cry for mercy and implore us very earnestly to stop the play of that wonderful medicine. Had there been any accidental explosion of chemicals so that one of the braves was blown up, he would have deemed it all a part of the show, and as soon as he caught breath would have exclaimed: 'What next? What in the world will these magicians do next?'"

The simplest French conveniences were sublime in aboriginal eyes. The Mascoutins, when Perrot appeared among them, knew no mode of producing fire except by rubbing two sticks together. Such friction was ineffectual whenever the sticks were at all wet, and they were often too damp to kindle—an Irishman would say—till one had made a fire and dried them. Naturally, Perrot's tinder-box was venerated as an angel from heaven. No wonder that a hundred dozen of these Promethean fire-bringers are set down in the outfit of La Salle. One of an antique pattern, lately discovered in an Illinois cave, was shown me in

Ottawa. Possibly it is one of the twelve hundred imported by La Salle. Had lucifers been known to the French, starting camp-fires in a twinkling, they must have converted every Indian into a fire-worshipper and conquered the continent.

The Indians wished that their children should grow up bald, aside from scalp-locks. Their style of hair-cutting had been to burn childish scalps with red hot stones. Hennepin's razor, though none of the keenest, was clearly a better depilatory, and so was hailed as a miracle of mercy.

Nicollet met in council four thousand Wisconsin warriors, who feasted on six score of beaver. He appeared before them in a many-colored robe of state, adorned with flowers and birds. Approaching with a pistol in each hand, he fired both at once. The natives hence named him "thunder-bearer." Such a spectacular display was in keeping with the policy which marked the old French regime in two worlds, and which for centuries proved equally sovereign in both. The apotheosis of Nicollet would have been complete if he could have carried a Colt revolver—the thunderbolt of Jove in the thimble of Minerva, omnipotent as ever, yet so small that Cupid would steal it, as no longer too heavy for him to lift or too hot for him to handle.

Of all Europeans the French only gained the *affections* of natives. From the beginning they fraternized with them as the British never could.

They never sold Indian captives for slaves on southern plantations as the English did. Through hatred of New Englanders fifty families of Indians there flying west became retainers of La Salle, and some of them were his most trusty oarsmen and braves in discovering the Mississippi. Four score years, said La Salle, have we had Indian allies. Never has one of them proved false to France. We can safely trust them with arms. From first to last the Illinois tribes were faithful to the French. When the French, after their loss of Illinois, went west of the Mississippi in 1763, the Indians followed them. Each tribe loved the French with an affection so ardent as to be jealous, and strove to keep them all to itself, resenting their dealing with any other tribe as a sort of adulterous infidelity. For a score of years Nicholas

Perrot won golden opinions among the Outagamies. After his departure they declared in council with the governor of Canada, that their fathers having gone they had no more any breath, or soul.

The French captivated the Indians and the Indians captivated them. For them, then, there was a fullness of fun — yes paradise where John Bull would have felt himself in such a purgatory that he could not fare worse by going farther.

One Englishman who had been forced to make trial of savage life, when asked how he liked it, answered: "The more I see Indians, the better I love dogs." But amid the same horrors a Frenchman enjoyed himself so well that he declares he was ready to burn his cook books! What could Frenchman do more?

In no long time most northwestern tribes were tinctured with French blood. Perrot treats of French among fugitive Sauteurs on the south shore of Lake Superior as early as 1661. The first permanent settler in Wisconsin, Charles Langlade, was a French half-breed. So was the first squatter at Madison — (long before the Peck family), St. Cyr, the only saint we could ever boast. In 1816, when the United States forces took possession of Wisconsin, the natives being assembled for treaties, said: "Pray do not disturb our French *brothers.*

Adventurers among western aborigines in time became fur-traders or interpreters and factors for such traders, as well as missionaries or other officials both military and civil. But their *first* impulse to plunge into the depth of the wilderness, and to abide there, was because they liked it. To their imaginations forest-life was as charming as the grand tour of Europe a generation ago to ours, or as is girdling the terraqueous globe at the present day, or as roughing it on the Yellowstone to General Sherman, or on the great divide to Lord Dufferin, or rounding the world on horseback to Sir George Simpson, or Beltrami's solitary scamper to the sources of the Mississippi, or the three years cruise of the Challenger to Lord Campbell, whose Log Letters skimming off the cream of all climes and finding no drop sour, cry out in every line, "O what Fun!" It was much more than all this, and can only be compared to the wild dedication of him-

self to unpathed waters, undreamed shores and sands and miseries enough by Stanley, in quest of Livingston, or the sources of the Nile and Congo.

Seekers of pleasure in the pathless woods followed Nicollet into *Wisconsin*, as well as elsewhere in the Mississippi Valley. Their race endured, and it still endures. Some survivals of it were met with in the first decade of our century far up the Missouri, by Lewis and Clark, and by Pike at the sources of the Mississippi. Within the last ten years, the British Major Butler, with whom I traveled down the Red River of the North in 1872, encountered them on his pilgrimages throughout the great lone land and the wild north land to the shores of the Pacific.

Enamoured of wild sports, the French more than two centuries ago rushed from Lower Canada into the borders of the Upper Lakes. They came the sooner thanks to unrivaled facilities for boating, hunting and fishing,— to an appetite for open air which grows by what it feeds on,— to their feeling at home in wigwams, to their passion to break loose from law martial and monkish, and to enjoy unbounded license, as well as to the pre-eminence which knowledge gave them among barbarians. To the love of fun, then, and the full feast of it fresh as the woods and waters that inspired it,— with which he could fill himself in western wilds, we in Wisconsin owe the explorations of Nicollet and others of like temper, and so our most ancient historic land marks. One of the first French foundations here was laid in fun. Fun then was *fun*damental.

But if fun led the way to exploring the far West, *faith* also was there, and not least in Wisconsin, a French foundation.

Faith followed hard after fun, and sometimes outstripped it. The friar, Le Caron, was on Lake Huron before Nicollet had penetrated half way there. Nicollet lingered in the Isle of Allumette, several hundred miles short of Lake Huron, till 1620. But, five years earlier, mass had been already said on that lake by the Franciscan with sandaled feet and girt with his knotted cord. The monk's passage had been paid by the governor, but he worked his own passage and that bare-footed, since shoes would injure the bark canoe. He thus wrote to his superior: "It would be hard

to tell you how tired I was with paddling all day among the Indians, wading the rapids a hundred times and more, through mud and over sharp stones that cut my feet, carrying the canoe and luggage through the woods to avoid cataracts, and half starved the while, for we had nothing to eat but porridge, of water and pounded maize, of which they gave me a very small allowance." Through the winter of 1615 in a hermitage a thousand miles west of Quebec which was itself an ultima Thule,— this friar was making catechisms or struggling with the difficulties of the Huron tongue, or expounding the faith in broken Indian, and by way of object lesson showing "four great likenesses of the Madonna suspended on a cord."

As early as 1614, when the French first ascended the Ottawa, they planted crosses of white cedar on its shores and islands. In 1625 the Jesuit Brebeuf began a three years' sojourn on Huron waters. Onward from 1634 a permanent mission was maintained there for fifteen years until the Hurons were scattered to the four winds. Missionaries followed them in their dispersion. In summer plying the paddle all day or toiling through pathless thickets, bending under a canoe or portable chapel heavy as a peddler's pack, veritable colporters, while famine, snow storms, cold, treacherous ice of the lake, smoke and filth were the luxuries of their winter wanderings. We underrate the arduousness of mission journeys until we consider how greatly storms, cold and famine retarded them. Allouer's voyage from Mackinaw to Green Bay consumed thirty-one days. Marquette was ten days more on his passage from Green Bay to Chicago.

Yet, in 1642, Madame de la Peltrie,— a tender and delicate woman,— reared in Parisian refinements, was seized at Quebec with a longing to visit the Hurons, and to preach in person at that most arduous station. In 1641, the year before one house was built in Montreal, Fathers Jogues and Raymbault were distributing rosaries at the mouth of Lake Superior. Previous to 1640 they had become acquainted with Wisconsin Winnebagoes. The earliest Iroquois baptism was in 1669, but thirty years before, scores of Hurons had been baptized hundreds of leagues further west.

The first clear trace of a priest in *Wisconsin* was in 1660. In that year Father Menard, paddling along the south shore of Lake Superior for many a weary week, near its western extremity, reached La Pointe — one of the most northern peninsulas in the region which is now Wisconsin.

"He evangelized the natives who flocked together there." Such are the words of the old chronicler. The meaning is, not that the Jesuit dispensed the whole gospel to the Indians, nor yet all that he could give, but only so much of it, such a homœopathic dose — as they would receive.

Early travelers into the Orient when they there met certain albinos thought them the posterity of blacks converted by St. Thomas and whitened by baptism. It seemed doubtful, however, whether such a skin-bleaching was a real improvement. In like manner, may it be questioned whether the western missionaries who had chosen St. Thomas for their patron were any more successful than he.

However we may speculate on this matter, we must feel that Menard's motives were the best. Sometimes he had no altar but his paddles supported by crotched sticks and covered with his sail. Moreover, he dared not celebrate mass in the presence of those he had there baptized, because it was beyond his power to convince them that that sacrament was not a juggling trick to secure for the priest slaves in the life beyond life. Father Allouez was less scrupulous. He boasts as of some great thing that he had taught one Wisconsin tribe to make the sign of the cross and to daub its figure on their shields. When one of these converts had married three sisters at once and was censured for it by La Salle, his defense was: "I was made a Christian against my will by Father Allouez." In 1672 this father was welcomed by Mascoutins whose head-center seems to have been not far from Portage City.

With Father Menard, in 1660, were three lay-helpers, whom he next year dispatched southward into Wisconsin to certain Hurons who had sought an asylum at the mouth of Green Bay. Having labored nine years for those Hurons in their old home, he soon followed his fugitive converts, but perished in the wilderness of the

Black river. It is believed that he was murdered by the Sioux, for among them his breviary and robe were discovered years afterward. That stream, now called *Bois Brulé*, forms the boundary between Wisconsin and Michigan, and it is not known on which *side* of it Menard lost his life. Both states may, therefore, with equal plausibility, glory in him as their *own* protomartyr. Wading through the sodden snow, under the bare and dripping forests, drenched with rains, braving every variety of unknown horror, faint, yet pursuing to the last, well may we, people of both states, count him worthy of double honor! Doubtless his last regret was that he had not a whole life to lay down for the salvation of each state.

Four years after, in 1665, Father Allouez succeeded Menard at La Pointe, and carried on his work. Very likely, as in the early days of Montreal, his only altar lamp was a vial full of fire flies. When he returned to Quebec for reënforcements, he remained there only two nights before starting back again with volunteer co-workers. La Pointe was then a four months' voyage from Quebec. He was saying mass at Green Bay to six hundred Indians and eight French traders in 1669, and the next year exhibited a picture of the last judgment, at Neenah, on Lake Winnebago. A silver monstrance, the case in which the sacramental wafer is held up for veneration, presented to the chapel of Allouez by the French governor, Nicolas Perrot, and bearing the date of 1686, was dug up, in 1802, at De Pere near the head of Green Bay, and is now treasured in the ambry of the cathedral there. In 1671, a chart (34 × 38 centimeters) was drawn, entitled *Lake Tracy* or *Superior*, with the dependencies of the Mission of the Holy Spirit [that is *La Pointe*]. It is still extant in Parisian archives, at the depot of marine charts. Two years later in the Jesuit relation of 1673, a map of their missions on the Lake of the Illinois [that is Michigan] was published.

In the same year the first white men, one of them a missionary, of whose journey a contemporary record remains, crossed Wisconsin from east to west. These adventurers were Joliet and Marquette — a noble brace of brothers. Equals in enthusiasm, the faith of Marquette, the Jesuit, rivaled the rage for discovery

in Joliet, the officer. These explorers were cultivated men, and experienced observers. For five years Marquette had been a western pioneer, partly in Wisconsin, and Joliet, while voyaging on Lake Superior some time before, had also probably trod Wisconsin soil. From Indian reports they had drawn a map of the region they purposed to penetrate, and kept it at hand as they rowed up Fox river, threaded the marshy maze at the grand divide and carrying place — now Portage City — and among herds of elk and deer, floated down the Wisconsin to the great river. Reaching this grand goal on the seventeenth of June, they glided with the current of the Mississippi for a month, and probably to the latitude of Memphis, which, according to their belief, was no more than two degrees north of the Mexican Gulf.

On the return voyage Joliet wintered at Green Bay, where he had found many good Christians the spring before. The next season, when he was about to land at Montreal, his boat capsized and he was only rescued himself after being four hours in the water. His journal was lost — a sad loss for Wisconsin, which was thus bereaved of the wayside notes of the earliest traveler throughout its whole breadth — a record which who would willingly let drown?

After all who knows but Joliet's loss may have turned out for our *gain?* and will still? Who shall count the investigators that, mourning for *Joliet's* misfortune, have thus, or shall, become doubly zealous to gather up and commit to the custody of our Historical Society — or of the art preservative of all arts — every fragment of our annals, letting nothing — no fraction — be lost?

Throughout the last third of the seventeenth century and in all generations since, priests of the Catholic faith may be traced in or near Wisconsin. There Allouez labored for a quarter of a century onward from 1665. In 1677 Frontenac speaks of the Green Bay mission as no new thing. All tribes near that Bay are mentioned in the missionary report for 1658. In 1680 and for seven years thereafter, Enjalran was stationed there. He had been preceded there by Fathers Andre and Albanel, and within a decade was followed by Nouvel, and three others whose names

are preserved. As early as 1671 their headquarters were Mackinaw, but they were constantly making excursions and establishing out-stations in the parts beyond. In 1721 Father Chardon had already labored among the Sacs about Green Bay till he had given them up as beyond hope, and was studying Winnebago in order to preach to the tribe of that name. Other missionaries are mentioned at later periods, and the town of De Pere, meaning *Fathers*, is said to derive its name from the fact that two Jesuits suffered martyrdom there in 1765. In the interior of Wisconsin there were also stations among the Kickapoos and Menomonies.

Downward from the expedition of Joliet and Marquette, Wisconsin was the favorite thoroughfare of missionaries as well as others bound for the southwest. Such way-farers shunned the east shore of Lake Michigan as infested by the Iroquois. If they could buy permission of the Foxes they glided down the Wisconsin river as the shortest and easiest route. Those who failed to win Indian favor paddled along the Wisconsin shore of Lake Michigan.

It is a natural question, " *What brought* the Catholic fathers to the farthest west at so early a day, while Protestant missionaries, though abroad in New England before one European dwelt in Montreal, had not penetrated half-way to the Hudson river?"

It might have been predicted from the out-set by a philosophical historian, that French missionaries would out-do all others among our aborigines. They had already showed themselves pre-eminent elsewhere. The French originated the crusades, and from first to last they were the chief crusaders. It was natural for them, changing tactics with the times, to be as zealous against the infidels of the occident as they had approved themselves against those of the orient, and as persistent with litany and mass as they had been with lance and mace. The presence and persistence of Jesuits on our upper lakes and beyond them, more than two centuries ago, is accounted for by one single word — yes, by one syllable, namely *Faith* — their peculiar faith.

The views I now present of Jesuit missions are of course those of a non-Catholic. They must be or they could not be my own, and no one would wish me either to dissimulate my own opinions

or to simulate those of others. My information, however, all comes from Catholic witnesses. No others existed then and there.

My account of the French missionaries must be the more one-sided because my present purpose will not let me expatiate upon their tact patience and heroic endurance amid all vexations, culminating in martyrdom. In temptations which we cannot bear to read of, their virtues found a fit emblem in that light from heaven which they came to bring,—sunbeams which, descending to the lowest depths of earth, and however reflected and refracted in abodes of pollution, remain unsullied and continue sunbeams still.

The Jesuits are the Pope's standing army (Loyola's own name for them was a battalion), and the title of their head is general. At the beck of superiors subordinates plunged into the vast unknown of our continent with the unquestioning alacrity of regular troops.

> Not theirs to question why,
> Not theirs to make reply;
> Theirs but to do, or die.

They knew no west or east, no north or south.

But in addition to his vow of obedience, each missionary was impelled by a faith which inspired him with tenfold more zeal and intrepidity. That faith was this: that he bestowed a clear title to heaven on all whom he baptized, unless they lived to commit mortal sins afterward. Hence when one had sprinkled a couple of dying children he writes in his diary: "Two little Indians changed to-day into two angels, by one drop of water. O, my rapture as I saw them expire two hours after baptism." No matter though the sprinkling was effected by pious *fraud*, when Jesuits unable otherwise to approach sick infants, pretended to administer a medicine of sweetened water, but spilled some drops of it on their heated brows, while whispering sacramental words with motionless lips. The little ones were sent to paradise by these waters none the less surely because secretly. Seeing that death quickly followed baptism, Indians soon inferred that it was occasioned by those priestly drops. They were hence prone to scalp a Father if they detected him administering the sacred rite.

We hear with a shock of *burning* prisoners *alive*. But the fathers had little to say against the custom. On the other hand, such an execution seemed to them a means of conversion akin to a Spanish *auto da fe*, and equally efficacious. One of the missionaries wrote home as follows:

"An Iroquois was to be burned some way off. What consolation is it to set forth in the hottest summer to deliver this victim from hell. The father approaches, and instructs him even in the midst of his torments. Forthwith the faith finds a place in his heart. He adores as the author of his life Him whose name he had never heard till the hour of his own death. He receives baptism, and in his place of torture cries: "I am about to die but I go to dwell in heaven." How history repeats itself! In 1877 the last words of Henry Norfolk on the scaffold in Annapolis were: "I am here to hang for the murder of my wife, but I thank God I am going to glory!"

Again, the record is: On the day of the visitation of the Holy Virgin, the chief Aontarisati was taken prisoner by our Indians, instructed by our fathers, baptized, burnt, and ascended to heaven, all on the same day. I doubt not that he thanked the Virgin for his misfortune and the blessing that followed. Happy thought!

Another missionary writes: "We have very rarely indeed seen the burning of an Iroquois without feeling sure that he was on the path to Paradise, and we never knew one of them to be on that path without seeing him burnt." Happy thought.

The conclusion of the whole matter then is: "The only way to save Indians is to burn them," or as they now say in Texas: "Scalp them first, and then preach to them."

Powerful motives then hurried the Jesuits wherever an infant was death-struck, or a captive in torture.

Various *secular* influences speeded the missionaries on their western way.

First, the spirit of religion was reinforced by that passion for romantic adventure which we have just been surveying. Then, according to Father Biard, the French *king*, the most dissolute of men, initiated the Jesuit project. Preachers who were overzealous he liked to ship off, and so transfer their soul-stinging ser-

mons to the other side of the Atlantic. He thus parried thrusts which might have hit his conscience more effectually, and yet more covertly, than the German duke can whose cathedral pew is hedged about with sliding windows, so that, when he pleases, he can shut out unpalatable doctrines. Again, the French monarch was as liberal in land-grants to Canadian priests as our congress has been to railroads.

Many of his courtiers too, whose idea of Lent was a month when they hired their servants to fast for them, paid roundly for sending so much gospel to the heathen as to leave very little of it for themselves. Others too who would not give a sou of their own money importuned their neighbors till they forced them to contribute, as the fox while sparing his own fur tore skin off the bear's back to make a plaster for the sick lion. Such beggary they thought was a means of grace.

While in lower Canada the Jesuits were to some extent subject to the secular arm, and occasionally were forced to beg the governor's pardon. The powers that were said to them: "Show us the way to heaven, but we will show you yours on the earth." When a Jesuit in a Quebec pulpit declared the King had exceeded his powers by licensing the trade in brandy in spite of the bishop's interdict, the governor, Frontenac, threatened to put him in a place where he would learn to hold his peace.

The same magistrate sent another priest — brother of the author of Telemachus — to France for trial owing to some disrespect, and wrote to the king: "The ecclesiastics want to join to their spiritual authority an absolute power over things temporal. They aim to establish an inquisition worse than that of Spain."

Amid this conflict of authorities the government was glad to transport the missionaries, and they were equally glad to be transported deep into the wilderness; for there all power in heaven and on earth, temporal and spiritual alike, and each doubling the other, was theirs, theirs alone, without rival. Every whisper against them was admitted to be "injurious to the glory of God." They held it better to reign monarchs of all they surveyed among Menomonies than to hold divided empire in Montreal.

When once the Jesuits were planted in the far west they suf-

fered no more from governmental jealousies. On the other hand trade-policy and military power leaned on missions as their main support. Missions were to explore the Mississippi, missions were to win over savage hordes at once to the faith and to France. At a momentous crisis, in 1685, the Jesuit, Engelran, at Mackinaw adroitly kept the lake tribes from defection. The Marquis Du Quesne used to say that Father Picquet was worth ten regiments. One tribe was taught by the Fathers that Christ was a Frenchman murdered by the English, and that the way to gain his favor was to revenge his death. No wonder a chief called out, "O, that I and my braves had caught those English crucifiers. We would have taken off all their scalps."

In those times, when the question arose which we are still vainly essaying to answer, "How was America peopled? how came the Aborigines here?" it was a common saying of theologians that the devil had led the Indians hither that they might be out of the way of the gospel. Accordingly, whoever penetrated into the utmost corner of the West was sure that he beyond all others was storming the donjon keep of Satan.

This Jesuit storming party, full of hope and misnamed forlorn, roved at will without passports, while others, if they lacked such credentials, were put to death.

Their first acquaintance with mosquitoes is thus recorded: "The woods were full of a species of flies similar to the gnats which in France are called cousins (that is, I suppose, 'poor relations'). They are so importunate that one always has a multitude around him watching for a chance to light on his face or on some part of his body where the covering is so thin that their stings can easily pierce it. As soon as they light they draw out blood and substitute for it venom, which excites a strange uneasiness and a tumor of two or three hours' duration." When they first saw a fire-fly they must have thought like Paddy that a mosquito had taken a lantern in order to find his victims in the dark.

In sending their underlings into the heart of New France, Jesuit superiors were assured they could there repeat those miracles of conversion and reconstruction which their order had lately wrought in South America.

In Paraguay they had built up a model state. The natives became tolerant of their culture and compliant to their bidding in every particular. They rose and sought their beds, were married and given in marriage, weaned their children, removed from place to place, raised stock or grain, fixed prices, and used their gains at the dictation of spiritual guides. They were docile, but undeveloped, or developed only in some single prescribed direction. They were literally sheep, submissive when fleeced and even flayed and slaughtered at the pleasure of their shepherds. But their development was arrested. At their best they never became men, but remained children of larger growth, or rather became weaker in mind as they grew stronger in muscle. The purpose was to build up a second Paraguay in North America. An experiment, tried in Lower Canada, had failed. Its want of success was attributed to the roving habits of the tribes and the impossibility of persuading them to renounce nomadic life. It was tried again, with more sanguine hopes, on Lake Huron, for the tribes there were fixed through the year in one abode. When the Hurons had been overpowered by foes and driven into Wisconsin, the experiment was repeated there.

The westward exodus of Hurons into Wisconsin began as early as 1650. Onward from that time the French became known there, and that most favorably, as a race superhuman in arms, in arts and in benevolence. Such must have been the report concerning them which fell from the lips of fugitive converts. It roused the braves on the farthest shores of the farthest lakes to set sail in quest of the admirable strangers.

Missionaries were the more encouraged to venture far west; thanks to *invitations* from the aborigines. As early as 1611, the first fleet of Hurons that descended the St. Lawrence to meet Champlain said to him, "Come to our country, teach us the true faith." In 1633 it is chronicled that Hurons vied with each other for the honor of carrying missionaries home with them in their boats of bark. The volume of Jesuit *Relations* for 1640, states that fathers, invited by Algonquins on Lake Superior, were on the point of pushing forward even to that most western sea.

In 1679 an Outagami chief, espying friars among La Salle's com-

pany near Chicago, cried out: "We love those gray robes. They go barefoot as we do; they care nothing for beaver; they have no arms to kill us; they fondle our infants; they have given up everything to abide with us. So we learn from our people who have been to carry fur to French villages."

Stations far inland and dissevered from their base on the seaboard, were also preferred as being undisturbed by the influx and influence of non-missionary and anti-missionary whites,—godless sailors who swarmed on the rock of Quebec,—and above all from the heretical psalmody of Huguenots which could not there be silenced.

Aside from the moral advantages of a mission in the heart of the land, the fathers and their employes, whether paid or volunteering without pay, were most numerous and useful when remote from other whites, because they were able to push trade in fur, free from competitors. The lay brothers together with brandy sold scapularies or belts of the Virgin which were of such sovereign virtue that nobody who wore one at his death could possibly sink to perdition. The missionaries, according to Governor Frontenac, wished to keep out of sight the trade which they always carried on in the woods. They also claimed that their profits never exceeded five hundred per cent. Parkman wrote his *Jesuits* more than a decade ago. He was then doubtful whether those missionaries engaged in fur trading. But the letters of Frontenac, often written in cipher for secrecy (lately discovered by P. Margry and published by our congress), leave us no doubt on this point. In 1674 he wrote Colbert that when he urged the Black Robes to labor near white settlements, they answered that their coming into America was to indoctrinate savages—or rather to draw in beaver. He accuses them of dealing in peltries. In 1682 La Salle wrote that the Green Bay Jesuits held the real key of the castor country, while their blacksmith brother and his two helpers converted more iron into fur than all the fathers could turn pagans into proselytes.

A further narrative by La Salle regarding Jesuit tactics, reads as follows: "A savage named Kiskirinaro, that is to say, Wild Ox, of the Mascoutin tribe, a considerable war chief among his people,

says that in a little river to which he wished to lead me, he had picked up a quantity of white metal, a portion of which he brought to Father Allouez, a Jesuit, and that brother Giles, a goldsmith who resides at Green Bay ("the bay of the Puans"), having wrought it, made the sun-shaped article [soleil] in which they put the holy bread. He meant the ostensory which this same brother has there made. He says that Father Allouez gave him a good deal of merchandise by way of recompense, and told him to keep the matter secret because [the metal] was a manitou — this is to say a great spirit who was not yet developed."

Nor were the most distant fathers altogether at the mercy of savages. A seminary for Huron boys at Quebec was projected in the outset, and was begun in 1636, two years before the building of Harvard College. One reason for founding this educational institution was that the Indian children in this Do-the-Boys Hall, would be hostages for the safety of missionaries, however distant in the interior.

It is a merciful ordination of Providence that the tragic suggests the *comic*, and all miseries have a ludicrous side.

The crew of Captain Nares in quest of the North Pole would have died of hypo in a darkness which outlasted a hundred times the space that measures day and night to us, had they not dipped deep in comic theatricals. Nor in the worse than Arctic gloom around them would the Jesuits have fared better, had not their eyes now and then rested on a silver lining of their sable cloud. Burdens, otherwise too heavy, they threw off by sportive notes in their diaries. Thus they must have felt a grim pleasure in writing down skunks as *infants of the devil.* Father Allouez relates that while publishing the gospel in the midst of Wisconsin he found himself in a sort of monkey France. Certain of the sequestered natives having carried beaver to Montreal had there beheld military pomp. Wishing to pay the missionary fitting honors, they stuck feathers in their hair, and organized the naked braves into a militia company who gravely mimicked every evolution of the governor's guard. The Jesuit discoursed to them of heaven and hell, but the unseasonable parody of French parade did not cease for an instant. The Black Robe could not

keep his countenance, but his guard of honor did keep theirs. Every savage executed every punctilio of his part with more than Spanish gravity.

When an Indian had been so scalded as to lose the skin of his face, a Jesuit writes: "It would have been very well if he had lost his old heart with his old hide."

Another Huron, finding no missionary assurance that there was tobacco in heaven, declared he would never go there. The reflection chronicled by the Father is: "Unhappy infidel! all his time spent in smoke and his eternity in fire."

Robes and ritual inspired a divine awe. This was sometimes betrayed in odd ways. No Black Robe's risibles could remain unmoved when he overheard converts who feared to address a missionary, but asked the most solemn questions of his dog.

Again, certain Christian Indians having caught a warrior of a heathen tribe, named Wolf, the Jesuits let them burn him, having first instructed and baptized him. Then with a pun on his name they recorded it as a marvel indeed, that a Wolf was at one stroke changed into a lamb; and through the baptism of fire entered at once into that fold which he came to ravage.

Priestly humor was sometimes *unconscious.* Thus Hennepin remarks that no sooner had he declared a fraction of the heroic virtues of "the most high, puissant, most invincible" (Almighty? no! but) King of France, to savages" than they at once "received the gospel and revered the cross."

Again when he had set forth certain mysteries the Indians told him some of their fables. But these, he told them, were false. Their answer was, we believed your lies; had you been as polite as we were, you would have believed ours." Again, the question whether the quid of a tobacco chewer, taken in the morning before mass, broke his fast, was discussed pro and con by casuists. To them it seemed a question altogether serious, however ludicrous on all sides it appears to us.

Again, when they noticed that a certain *beardless* priest was a special favorite with natives, they sent to France for pictures of Christ painted without a beard.

After some analogous scrutiny of Indian tastes they wrote in

their next order for paintings, "one view of celestial rapture is enough, but you cannot send too many scenes of infernal torments."

Again, "if three four or five devils were painted torturing a soul with different punishments, one applying fire, another serpents, another tearing him with pincers, another holding him fast with a chain, this would have a good effect, especially if everything were made distinct, and misery, rage and desperation appeared plainly in the victim's face."

Within fifteen years after Jesuits began work in earnest among Hurons, that tribe was either annihilated or expelled by the Iroquois. But for that catastrophe the faith of the Jesuit might have been to this day more dominant in Upper Canada than it is in Lower.

Some tincture of it has survived everything in all Indian dispersions. One of the first English adventurers to Maine was greeted by the natives with a pantomime of bows and flourishes which in his judgment could have been learned of nobody but a Frenchman. The aborigines in general were inoculated with French faith and French fashions so that they took about as much of one as of the other,—and not much of either. Disciples who ran wild in the woods retained some prayers and chants learned by rote. The divine vision which roused Pontiac and his compatriots to war, was a woman arrayed in white. Had they not been taught concerning the Virgin Mary, it could hardly have taken this form. In 1877, a white man who had been caught by a Rocky Mountain tribe chained to his wagon-wheel and half burnt, when he made the sign of the cross was snatched out of the fire. The hunting camps of tribes in Manitoba are to-day called Missions.

Missionaries, then, burning to propagate their faith, more than two centuries ago penetrated into our Northwest, some of them into Wisconsin. They there discovered tribes having fixed abodes, over whom their knowledge and tact gave them power, so that they molded them as clay in the hand of a potter, where their influence was unchecked by white intruders, and where they could so trade as to make their enterprise self-supporting.

The *third* stepping-stone of the French into the northwest, and thus into Wisconsin, was *fur*.

The fur trade would have drawn them thither, even if fun and faith had not paved their way. Indeed, that trade began to attract them to American shores before either fun or faith had worked at all in that direction.

After all, *fish* was the *first* magnet which drew Frenchmen across the Atlantic. According to a manuscript in the library at Versailles, when Cabot (before Columbus had landed on continental America) discovered Newfoundland, he heard the word *baccalaos* there in use for "cod-fish." But "baccalaos" is the Breton-French word for that fish. It is possible then that Bretons, next to the Norse, were the true discoverers of America — pre-Columbian and pre-Cabotian.

However this may be, fish, indispensable for fasts and not unwelcome at feasts, were sought by Bretons off Newfoundland, a century before Quebec was founded. In 1578, there were one hundred and fifty French vessels there.

But peltries, already scarce in Europe, filled the land in that quarter no less than fish the sea, and were hunted as early. Before the close of the sixteenth century, forty convicts, left on a Nova Scotia island, had accumulated a quantity of valuable furs.

But, what is far more surprising, Menendez relates that fifty-five years before the landing from the May Flower — in 1565 — buffalo skins had been brought by Indians down the Potomac, and thence along shore in canoes to the French about the St. Lawrence at the rate of three thousand a year.

But not content with coast traffic, and with a view to escape the rivalry and hostility of Dutch and English, as well as in quest of *fresh* fur fields, traders pushed inland. Before the year 1600 they had a post at Tadoussac, at the mouth of the Saguenay, and in 1608 established themselves at Quebec.

To this emporium Indian flotillas, year by year larger and larger, and from districts more and more remote, resorted. They came laden with furs, and drawn thither by what they counted miracles of beauty and ingenuity, which, bartered on the coast by the first comers, had glided up the St. Lawrence and all its tributaries, and even to the great lakes, where beaver were most and best.

They were further attracted by the presents and invitations of Champlain, who, in 1615, within seven years after the first tree was felled at Quebec, had held councils on Lake Huron, and bidden the natives to bring down their furs. Western Indians were still more stimulated to traffic by adventurers, who, as we have seen, had in 1609 begun to be domesticated among the aborigines and to share their hunts. Wrapped in furs, striding on snow shoes with bodies half bent, through the gray forests and frozen pine swamps, among black trunks and dark ravines, these young Frenchmen, though they meant not so, were commercial travelers, and they fulfilled their mission as shrewdly as those who now sally from Chicago. Those Chicago emissaries are dextrous dealers, yet very possibly might learn some *new* tricks of trade could they recover the lost arts of their forerunners whose palace cars were bark canoes, and their commercial hotels wigwams. Drummers from the lake-metropolis now encounter men of their own stamp from St. Louis. So did the early French agents conflict even in Illinois and Michigan with those who had been dispatched from the Hudson. In order to get beyond New York competitors, the French hurried still further *west* than they otherwise would have ventured.

Again, these roving and fraternizing Frenchmen did not long go among the aborigines empty-handed, or even selling by samples. They took with them into the heart of the land those goods — light and cheap — for which the Indian demand was the greatest.

At sight of an iron hatchet, says Perrot, Wisconsin tribes raised their eyes blessing heaven for sending them a race able to furnish so powerful a deliverer from all their woes. Every bar of iron was in their eyes a divinity. But *brandy* was from first to last the one thing needful in a trader's outfit. It was indeed contraband according to the dignitaries of both church and state. Yet then as now it had free course on some underground railroad. It was more easily *carried* because, before exposed for sale, it was *watered* as profusely as the stock of our railroads. Each gallon of proof liquor swelled to six. The lowest *price* for brandy was a chopine for a beaver skin. How much a French chopine

amounted to you cannot easily learn from books. French and English measures were incommensurable. But what I long sought in vain, I have learned from the casual remark of an ancient fur-trader, that a chopine was so small a quantity as would not make an Indian drunk more than *once*. An Indian is quite unlike an *Irishman*. But in one thing they agree. Neither is consciously guilty of a bull when he says: "Give me the superfluities of life and I will give up the necessaries. Traders too scrupulous to sell liquor to an Indian, would still exact a beaver of him for a single four pound loaf of bread.

French commercial men bore a *charmed* life. The fiercest savages spared both them and their goods, lest no more of that desirable class should come among their tribes. They had too much *wit* to kill the geese who were their only hope of golden eggs. La Salle's testimony is: (M. 2,284.) "The savages take better care of us French than of their own children. From us only can they get guns and goods." Hennepin relates that he would have been scalped by his Indian captors had they not judged that his death would hinder others of his countrymen from bringing them iron.

French traders soon brought with them more merchandise than they could transport overland. They were thus led to establish trading *posts* on navigable streams and at carrying-places. We naturally think such commercial stations would be set up first along the *St. Lawrence* and *Lake Ontario*, those natural highways to and from the west. They were *not*. Those waters were watched by the *Iroquois*; fiercest in fight of all Indians, foes of France, allies of Holland and England. Accordingly the thoroughfare of western Indians to Quebec and of French traders to the upper lakes, was by the *Ottawa*, a river which, lying farther north, was comparatively safe from Iroquois ambuscades, which were with reason more dreaded than cold, famine, storm and cataract.

Hence it came to pass that the French while they still knew nothing of Lake Erie and Niagara, were familiar with Lake Superior. Two of their traders had penetrated into that inland sea in 1658.

Even after the French were at peace with the Indians on the

south of the St. Lawrence and Lake Ontario, they were no match on those waters for Dutch and English rivals in fur trading. The latter could afford to pay four times as much for furs as the French could. Nine pence was the export duty on a beaver at New York; in Quebec it was six times as much. In New York fur-trade was free. At Quebec seven hundred crowns were charged for permission to send a single boat up the Ottawa. Good reason then had the French to seek furs so far northwest that they could escape European competitors.

The result was that they had reached Lake Huron in 1615, and soon hurried on to Michigan, while they had no port on the nearer lake, Ontario, till two generations afterward in 1673, when they threw up Fort Frontenac at its outlet, where Kingston now stands. Its builder, Frontenac, intended it merely as a base of operations for fur trade so far west that he would be independent of the governor of Montreal. Seven years afterward in 1679, La Salle, having launched the first sloop ever built on Lake Erie, voyaged in her through St. Clair, Huron and Michigan to the mouth of Green Bay.

His vessel was there freighted with rich furs, but as she was lost on her first passsage eastward, La Salle's experiment did not recommend the lower lakes. On the contrary it tended to make the upper, or Ottawa route, more popular than ever.

The doors into Wisconsin were two,— La Pointe and Green Bay, and these two were about equal favorites. The first missionary arrived at La Pointe in 1660. Fur traders came *with* him. Nine years after, in 1669, when Father Allouez reached Green Bay to found a mission, fur traders were on the ground, and had become so domineering in that end of the world, that the missionary was brought by the Indians from Lake Superior as a protector.

Nicholas Perrot, who in 1683 built a fort near the mouth of the Chippewa river, though on the west bank of the Mississippi, had entered Green Bay eighteen or twenty years earlier. He wrote a volume,— not for publication — but for the information of the Canadian government. In this work which was first printed less than twenty years ago, in 1864, he describes a score of journeys in

all parts of Wisconsin, all of them having something to do with fur. How fully even in his lifetime the region between Lake Michigan and the great river had become known to the French, is plain from the early geographical *names* being largely French.

Le Sueur, who passed up the Mississippi in the year 1700, mentions between the Wisconsin and the St. Croix, six rivers with French names, all apparently of long standing. These rivers were Aux Canots, Cachee, Aux Ailes, Des Raisins, Pasquilenette and Bon Secours. In other parts of Wisconsin not a few French names run back as far as these on its western border.

In 1654 Father Le Mercier at the outlet of Lake Superior wrote that about Green Bay, nine days' journey distant, there were Algonquins, and that if thirty French were sent there they would not only gain many souls to God but would receive pecuniary profit, because the finest peltries came from those quarters. The next year fifty canoes of these Indians visited Quebec, and thirty Frenchmen returned with them. Among Ottawas between Green Bay and Lake Superior French traders are mentioned in 1659. In 1665 Perrot was buying beaver of Outagamies in or near the Wisconsin county in the name of which they still live, and in the following year the second flotilla of Pottawatomies had reached Montreal.

French fur-factors penetrated the further into western fastnesses, because by this means they practically enjoyed *free-trade.* Making bark canoes far inland they evaded the crushing imposts on all canoes allowed to pass up. While mother-states were all at war, they plied friendly commerce with Dutch and English middle-men as well as their Indian confederates. Thus their beaver were either exported through New York, dodging the French tax, or they were bartered there for blankets cheaper and better than were to be had in Canada.

As a rule the French governor and intendant were at swords' points with each other. Each would charge the other with a heinous offense—carrying furs to the English province. The truth is that each of them was determined to be the *only* sinner in that line. Each thus resembled the usurer who was delighted with a sermon against usury, paid for *printing* it and said to the

preacher, "Make *more* such discourses! Stop everybody from taking high interest — except me. Then I can monopolize the whole business." As his recompense for risks and outlays in western discovery, La Salle asked nothing but the exclusive right to sell the skins of buffaloes.

Royal monopolies of fur-trading, lavished in Paris on court favorites or on corporations as the Hundred Associates, *crippled* that traffic near the *coast.* But they drove the bulk of that business into the *heart* of the continent, where it fell into the hands of traders so distant, shrewd and self-sufficing that it could not be crippled. Over a region vaster than any European kingdom, the bush-rangers carried on the fur-trade after their own pleasure, and laughed at royal restrictions on their dealings.

In 1681 Hennepin, at Mackinaw, met with forty-two Canadians who had come thither to trade in furs, defiant of the orders of their viceroy. These foresters were not without a sort of *conscience,* for they all begged the Jesuit to give them the cord of St. Francis, which was believed to make their salvation sure if they died wearing it as a girdle, and they all gained their request. Hennepin was then journeying eastward from Green Bay, where he had been entertained by the same class of contraband traffickers. There similar adventurers — La Salle informs us — had a permanent post in 1677, and that bay had even been visited by a brace of voyagers more than twenty years before, in 1654. Before La-Salle began his explorations in 1679, his employes were familiar with far western tribes. One of them, Accault, had spent two winters and a summer in Wisconsin. Before 1680, *Duluth,* with a score of followers, was trading as far inland as the city which now bears his name. He proclaimed that he feared no authority and would force the government to grant him amnesty. (M. 2, 251.) The sloop which La Salle in 1679 had dispatched to Niagara before he started from Green Bay for Illinois, according to his conviction was scuttled by her crew, who plundered her and struck into the northwestern wilderness, meaning to join hands with Duluth. (M. 2, 327.) Years afterward La Salle heard of a French captive on the upper Mississippi whom he identified as his pilot, and learned that hand-grenades, which could only have come

from the missing vessel, had been taken by savages from that captive.

In order to buy cheaper of Indian trappers, wandering fur hunters would report *pestilence* as prevailing in Montreal, and thus frighten savages from paddling down the river. Such fur-factors were outlawed on the upper lakes, and they could not dam up their outlets, but they intercepted many a flotilla anxiously expected from above in Montreal. Thus masters of the situation, they resembled those cunning Athenians who Aristophanes tells us were suspended in a sort of balloon, stopping incense as it rose from Jove's altars, and letting no savor of it reach Olympian nostrils, but keeping all for themselves.

On a long march every thing not totally indispensable is dropped. Hence the far western dealer carried no scales or steel yards. But he was himself a better weighing machine, for himself at least, than any witty invention of Fairbanks with all Howe's improvements superadded. So the saying was about Duluth: "Duluth, an honest man, bought all by weight, and made the ignorant savages believe that his right foot exactly weighed a pound. By this for many years he bought their furs, and died in quiet like an honest dealer."

In selling to Indians, however, the pound was no doubt quite a different weight. In the journal of a missionary at the outlet of Lake Superior I find that in 1670 a beaver was there valued at either four ounces of powder, or one fathom of tobacco, or the same length of blue serge or six knives.

Wood-ranging fur men seemed an evanescent race. Nevertheless they outlasted French empire in America. In latter times when English and Yankee fur-companies were organized in Montreal and New York they were unable to dispense with the French operatives, "to the manner born." Generation after generation they retained them as practical men fittest for all works relating to fur. In all governmental departments the higher functionaries, when first elected (and too often to the very end of their career), need to be taught official routine. Hence officials of lower grade who have learned to run the machine, are retained without regard to political revolutions. These factotums are sig-

nificantly called "dry-nurses." Such dry-nurses for English and American fur kings were discovered in French underlings.

Fun and faith both gave a new impulse to the fur trade. With it they formed a three fold cord which drew the French from end to end of the Mississippi, as well as to the farthest fountains of the St. Lawrence, and even further. La Salle deserves deathless fame, and will have it, because he was first to follow the Mississippi down to the gulf. But his grand object was to secure an outlet for fur that was not half the year frozen up, and the other half infested by English rivals, Iroquois ambushes, and worse than all, Canadian farmers of the royal revenue. Duluth, whose name we have seen revived and bestowed on a mushroom metropolis, "the zenith city of the unsalted sea," two centuries ago had penetrated beyond the farthest corner of our innermost and uppermost lake. His mission was to intrigue and foil the English on Hudson Bay. Ere long a French fort rose on the Saskatchawan, two thousand miles, as men traveled, from the seaboard. This station came up under the auspices of the French Company of the Northwest, incorporated in 1676, in antagonism to the Hudson Bay Company, which came into existence six years earlier. It long bore sovereign sway over a wide savage domain.

The natives preferred the manufactures of the English, but the manners of the French. Like all savages, they were swayed by impulse more than by interest. They would give more for one plug of tobacco brought to their wigwams than they could buy twenty for in Albany or Hudson Bay. Hence they traded with the French, and became their tools. One result was that in 1684, and again three years after, Nicolas Perrot, the supreme fur trader and Indian negotiator of his time, persuaded five hundred Indians from Wisconsin and near it to paddle their canoes all the way to Niagara in order to fight for the French.

In 1724, Bourgmont was already exploring the Upper Missouri. But on this line of Western research Verendrye outstripped all others. Pushing on step by step for ten years, he discovered the Rocky Mountains in 1743 on New Year's day, sixty-one years before our Lewis and Clarke. The point of his discovery was just above where the Yellowstone joins the Missouri. That re-

gion was so full of fur that the governor's share in the profits of a trading company soon amounted to 300,000 francs.

Those who, from mere love of fun, explored unknown woods and waters, learned strange tongues and ceased to be strangers among strange tribes, and unawares acquired all the requisites for successful commerce in beaver. Missions also, though founded in faith, by faith and for faith, furnished as good a base for the enterprises of furriers as if they had owed their origin to the spirit of mercantile speculation.

There is no danger of overrating the pervasiveness of French fur dealings in the Northwest centuries ago. We may well believe no cove, no navigable stream was unplowed by their boats of bark; no tribe, no council unvisited.

The demand for fur in France was stimulated by royal decrees. In 1670 one of them prohibited the manufacture of demi-castors, a sort of hats that were only half made of beaver. Soon afterward a prohibitory duty was laid in France on all furs not from French colonies.

Statistics are stupefying, and there is some wit in the quip, "A fig for your *dates!*" After all a few figures are necessary if we would understand how speedily and how grandly the trade in skins was developed, or how long and how widely fur was king as truly as cotton or corn has become so in our times.

In 1610, ten years before the landing of the forefathers at Plymouth, the boats of fur traders were at the outlet of Lake Champlain. Three years after forty canoes came down to Montreal bringing fur. In 1690 their number was 165; three years after, it rose to two hundred. For a decade before 1649, the Huron beaver harvest was valued at half a million francs a year. Fifty francs would then feed a man for a twelvemonth, and one hundred and fifty would pay a soldier. In 1674, the skins imported into Rochelle were 311,315. The governor of Montreal, whose salary was a thousand crowns, soon cleared fifty thousand by illicit fur dealing.

As early as 1670 there is mention of a fur fleet embarking at Green Bay for Montreal. Even before this, as we have seen, adventurers to Wisconsin waters and its interior, paid the charges

of exploration by an incidental trade in fur. Just afterward, the first Indians whom Marquette met on the Mississippi, were wearing French cloth. During the winter of 1674–5, when that missionary lay sick at Chicago, two traders were already encamped in the vicinity.

For more than a hundred years, the Northwestern beaver trade flowed on with a colossal and all-pervading stream. In 1791, the skins collected there for Montreal merchants amounted to more than half a million (565,000). A few years after John Jacob Astor, "sagacious of his quarry from afar," engaged in this traffic with hundreds of boats, thousands of men and millions of capital.

Green Bay was his point of departure, as Mackinaw had been that of the French for many generations. But his employes pushed through the continent to the western ocean. Most of his fortune came from fur, and it would have been twice as large, but for the war of 1812. But even Astor's fur agents of all classes were largely descendants of French voyageurs who had taken up their abode in the Northwest ages before.

Falsehood and false fancies were also among the forces which first hurried the French far west.

It is through no longing for alliterative initials that I add false fancies and falsehood as a fourth force to fun, faith and fur. At that period all travelers, if not Munchausens themselves, believed Munchausen stories, and when people are willing to be deceived, they are deceived. Demand for lies never lacks supply.

One Frenchman in Florida, when he saw a squaw so wrinkled that there was no room for one furrow more, believed the report that she had outlived five generations. Another, near Newfoundland, landed on an isle of demons not without wings, horns and tails. A third, when certain Canadian chiefs told him of a race who had but one leg and lived without food, took them to France for repeating their story to the king. These were sons of men who had been credulous to Venetian merchants, who, selling spices for their weight in gold, advertised them as no product of the vulgar earth, but plucked from branches thrown down from the battlements of Eden by compassionate cherubim. The age of faith was not yet over. As recently as the last year of the seven-

teenth century a company formed in France to work a mine of green earth reported to exist at the sources of the Mississippi, sent a party of thirty miners up that river. Their voyage up stream lasted ten months.

Among the earliest volunteers from the retainers of Champlain to ascend the Ottawa with savages, who had descended from a country no white man had ever trod, was Vignan, in 1610. On his return next season, he declared that he had pushed on to a salt sea, seen the wreck of an English ship, and heard of Cathay and Zipango,—so China and Japan were then called—as not far away.

The spark fell in gunpowder. Champlain heard not only what he wished to believe, but what all men of his time and a century after held for certain, that a short Northwest passage to the East Indies existed, and would at once double the wealth of any nation which could appropriate it by right of discovery. His own fleet had been equipped in 1608, not merely to colonize Acadia, but "to penetrate inland even to the Occidental sea and arrive some day at China."

He believed that in 1609 a vessel, clearing from Acapulco,—a Mexican port on the Pacific, lost its reckoning in a storm, but after two months found itself in Ireland,—and that the King of Spain had ordered the journal of the pilot to be burned so as to keep foreigners from knowing the course followed, but which was supposed to be north of Canada. The map of Verrazano, then still an authority, in addition to the Isthmus of Panama showed another no less narrow near the latitude of New York with the Pacific beyond it on the West.

More than three score years afterward, La Salle sought that East Indian route by way of the Mississippi. His estate just above Montreal was, and is still, called or nick-named, *La Chine*, that is China, because he started from there bound for the Empire of Celestials. Years after he had stood at the mouth of the Mississippi, he spoke of that river as separated from the China sea only by the breadth of the province of Culiacan, and was confident of meeting not far from the mouth of the Missouri, with rivers which flowed into the ocean he sought.

England shared in the delusion that the Pacific was near the Atlantic. Hence a barge was sent over to John Smith in Virginia with orders to row it up the Potomac, carry it over the mountains, and launch it on some stream that flowed into the South sea, which was afterward made the western boundary of Connecticut.

The truth is that French and English alike had a short cut to China on the brain. No sooner then had Champlain heard the story of Vignan than he hastened up the Ottawa with a crew of enthusiasts. Thirty five carrying-places and an infinity of hardships seemed nothing to him. When half way to Lake Huron — at the Isle of Allumette,— he detected the imposition which Vignan had practiced upon him. Champlain was more magnanimous than certain prospectors lately led into the Black Hills by a guide who promised them diggings that would yield thirty cents a pan, and finding him a liar straightway strung him up on the nearest tree. Champlain was more disappointed than the prospectors — yet he forgave the impostor.

The next year, 1615, taking a fresh start, he reached the head of the Ottawa, crossed to Lake Huron,— held councils with divers nations on that inland sea, hearing of still other seas beyond — and saying to one and all: "Bring furs down to Quebec and show me the way to China." Plainly he thought one request as easy to grant as the other.

The name of the first Wisconsin tribe with which the French became acquainted, and that before 1640, namely, *Winnebagoes*, was understood by them to signify *Saltwater* men, and western saltwater they associated only with the Pacific. Nicolet, the first white man on the Wisconsin (?), having voyaged down that river within some five and thirty leagues of the Mississippi, believed himself within three days march of the great sea of the west.

The Indians were always notorious for reporting whatever they perceived that whites desired to hear. They thus hoaxed them all alike. Spaniards they tickled with stories of gold, New England Puritans by legends concerning the Great Spirit, and so they amused the French, who came with a passion for China, with accounts of a Celestial empire.

At that era various nations were rivals in searching for new routes to China,— the English through Hudson Bay, the Dutch north of Lapland, and the French by way of the Great Lakes. They had all been denied access to the East Indies either by the Cape of Good Hope or of Horn,— which Spain and Portugal respectively blockaded, treating as privateers all who tried to pass. But their hopes were sanguine of finding another road thither, as the Italians when at the fall of Constantinople cut off from their mediæval thoroughfare eastward from the Levant, had set their faces westward and discovered America. The spirit of the age, "the grandeur of which," Froude pronounces "among the most sublime phenomena which the earth has witnessed," felt that only a corner of the veil had been lifted. All past findings just gave enough to wake the taste for more.

Champlain was the more thoroughly persuaded that the Pacific was near Lake Huron because he had himself beheld Pacific surges at Panama, the longitude of which is not so far west as that lake by a dozen degrees. His sight strengthened his faith, which was never weak. Quartz pebbles picked up on the river bank at Quebec he thought diamonds, and gave the rock above the name it bears to this day — Cape Diamond.

On Joliet's return from down the Mississippi, Frontenac's first feeling was regret that that river had not borne the explorer to the Pacific and to Japan. His next emotion was hope that the Missouri — still anonymous, but called by Joliet a northwest branch entering the Mississippi in latitude 38 degrees — could be ascended to a lake with an outlet into the Vermilion Sea — his name for the Gulf of California. Seven years later, in 1680, Duluth, near the head waters of the Mississippi, heard of Hennepin as a captive among the Sioux. He sought him out, procured his release and escorted him to Green Bay. But for this call to a mission of mercy, "my design was," says he, "to push on to the sea on the northwest, believed to be the Vermilion Sea, from which a war party had come among the Sioux. Some of its salt they gave to three Frenchmen that I had sent out as a scout, and they brought it to me. According to their report it was no more than twenty days' march to a great lake the water of which was

not fit to drink, and which I had no doubt I could reach without difficulty."

But all varieties of Frenchmen in America — the fur-hunter, the votary of fun and frolic and the apostle of faith — whatever their primary impulses, each man was inspired to dive further into the west, by a lurking but fixed idea that he was himself the predestinated Columbus of the grand discovery — that portal through which men should bring the glory and honor of the nations to and from farthest India — that world's highway which lay hid from princes and plebeians till in the fullness of time California opened wide her Golden Gate on golden hinges turning.

Only those of us who remember when California burst on the world like a sun-burst, or lightning shining from the west unto the east, as El Dorado no longer fabulous, can understand the fever and frenzy which burned in every man who set his foot toward the western unknown; his assurance that he was to be the revelator, not of an ignis fatuus or desert Nile fountain, but of greater marvels than are dreamed of in all the Arabian Nights — a fairyland where urchins play at cherry-pit with diamonds, where country wenches thread rubies instead of rowan berries for necklaces, where the pantiles are pure gold and the paving stones virgin silver. For such merchandise who, though no pilot, would not adventure to the farthest shore washed by the farthest sea?

"The blood more stirs to rouse a lion than to start a hare." Accordingly the illusions, that sheening far celestial seemed to be, of the China-seeker, the missionary and the fun-lover, yes, of the fur-dealer, roused them to efforts and crowned them with successes they could never have made had they seen things as they really were.

Celestial visions flitting always a little ahead of western wanderers were an analogue of Sydney Smith's patent Tantalus. This was a bag of oats hung on the pole of his carriage. It rattled before the noses of his horses, but was about a foot beyond their reach. In both cases, also, the stimulating influence was very similar.

Another French foundation was laid in the far west by political *finesse* and *feudalism*.

The apostles of faith were also political intriguers. They knew that nothing but the supremacy of France could afford a oasis for permanence in their missions. Accordingly, of themselves they worked for French domination as for self-preservation, and they were often formally appointed ambassadors.

Moreover, they sometimes established a sort of theocratic feudalism, or oriental patriarchate, in which they were themselves lords paramount.

According to Parkman, "it behooved them to require obedience from those whom they imagined God had confided to their guidance. Their consciences then acted in perfect accordance with the love of power innate in the human breast.

"These allied forces mingle with a perplexing subtlety. Pride disguised even from itself walks in the likeness of love and duty, and a thousand times on the pages of history we find hell beguiling the virtues of heaven to do its work. The instinct of domination is a weed that grows rank in the shadow of the temple." (Jesuits, p. 159.)

Always and everywhere Jesuits have been charged with usurping political sway. In 1667, the Canadian Intendant, Talon, addressed a remonstrance to Colbert, the French premier, complaining that the Jesuits "grasped at temporalities, encroaching even on that police which concerned magistrates alone." This complaint related to intermeddling on the St. Lawrence. But on the Upper Lakes and beyond them, there could not be too much Jesuit domination to please French statesmen.

But another class of political agents were very early abroad in the west. Nicolet, whom I have mentioned as in Wisconsin in 1634, and probably the first white man ever there, had been dispatched to Green Bay as a peace maker between the tribes of that vicinity and the Hurons.

Soon after the year 1650 the Iroquois had vanquished all the tribes east of Lake Michigan. They expelled them from their old homes, and drove most of them beyond that lake, some of them even beyond the Mississippi. In this flight the Ottawas descending the Wisconsin, and pushing up the Mississippi some dozen leagues, entered the Little Iowa and sought an asylum on

its upper waters. For those tribes who lingered in Wisconsin there was no hope of fighting the Iroquois fire-arms without fire-arms, and no hope of fire-arms except from the French. The governors of New France, to whom the Iroquois were sworn enemies,— at once saw the policy of lifting up these fugitives, uniting them in amity to each other, and to the tribes where they had fled for refuge, supplying them with kettles, tobacco, but above all with guns and powder,— in a word by every means stealing their hearts. For this end they dispatched into Wisconsin and further a species of envoys of which Nicolas Perrot was a good representative.

This Indian commissioner had been prepared for his functions by much western experience. He was first in Jesuit employ as a lay-brother, and then became an adventurer in quest of fun and fur where no white man's foot had trod. No doubt he was in make half Indian, and when present at a war dance would lead it, like Frontenac at three score and ten, whooping like the rest, or rather outwhooping them all. The Indians named him "Pop-corn," perhaps because when heated he seemed to them to grow ten times bigger, like the dwarf who declared that though his avoirdupois in the scale was ordinarily only one hundred and twenty pounds, whenever he got mad he weighed a ton.

His official career in Wisconsin began at latest in 1665. After making friendship with the Pottawatomies at Green Bay, he pushed up Fox River and into a lake of which it is an outlet. There he held a council with the Outagamies. After this fashion he went on for five years,— at home with tribe after tribe — at home in the customs and dialects of all the enormous angle between the upper Mississippi and the upper lakes. He brought many nations into a confederation with each other and against the Iroquois. His fame, like Solomon's, brought visitors into Green Bay from the uttermost parts of the earth,— some who spoke of trading with Mexican Spaniards and others who described white men far north in a house which walked on the water — meaning the English on Hudson bay. (2 178 La Potherie.) How he was borne aloft on a buffalo robe, reverenced for fashioning iron as squaws did dough in a kneading trough, and feared as holding in his hands thunder and lightning, we have seen already.

In 1671 he was interpreter for a dozen nations whose delegates largely through his persuasions then gathered at Mackinaw and acknowledged the sovereignty of France. His influence over them was seen in 1684, and again three years after, when, as I have before stated, he induced five hundred warriors from Wisconsin, and near it, to paddle their canoes many a hundred miles in order as allies of the French to fight against the Iroquois. According to Indian ideas his greatest exploit was delivering from torture and death a captive whom the savages had resolved to burn. No common miracle was it to make Indians forego the ecstasy of beholding and gloating on an enemy in agony. The French then aimed to make the western chiefs do homage to their king as a suzerain, and fight shoulder to shoulder in his battles.

But many adventurers from France also sought to become themselves a sort of feudal barons. To this end they secured patents of nobility with land-grants, termed seigniories. Some of these bordered on the St. Lawrence and Lake Champlain. But these eastern estates just gave enough to wake the taste for more. At the outlet of Lake Ontario La Salle possessed a domain stretching five leagues along the shore, besides others almost boundless on Lake Michigan, and whatever in other unknown regions he could conquer. As Col. Colt invented a patent revolver, so La Salle expected to hold as a patent-right the realm he had revealed. He was sanguine that his principality would be more attractive to immigrants than Canada. It was prairie which needed no clearing,—it was more fertile, of milder climate and more varied products, many of them—as salt, grapes and hemp—unknown in Canada. Not a few similar land-claims based on governmental grants were set up by French occupants when the United States assumed jurisdiction over Wisconsin. The Norman race which centuries before had feudalized all Europe, now meant to master the Mississippi Valley. French wanderers were not unfrequently elected chiefs of tribes. Perrot was so honored among nine different nations. French officers also came with a retinue of their own countrymen, whom they ruled by martial law, being sometimes judge, jury and executioners all at once. This one-man power, where no law was known but his will, was

the secret of many a success. It inspired a salutary fear where the common law of England and even the civil law of continental Europe would only have provoked contempt.

At Frontenac La Salle wrought wonders. The natives were compliant to his will like clay in the hands of a potter. At his bidding they settled near his fort, cleared land, tilled it, worked on the fortifications and on houses, sent their children to school. According to Parkman, "seignior by royal grant of water-front for five leagues,—feudal lord of the forests around,—commander of a garrison raised and paid by himself,—founder of the mission,—patron of the church,—he reigned the autocrat of his lonely empire." Nor was he altogether destitute of feudal trappings,—for, according to his chaplain, Hennepin, on state occasions he wore a scarlet mantle laced with gold.

On the Illinois river his success was still more marvelous. The colony he there extemporized was reckoned in 1684 to contain 4,000 Indian warriors or 20,000 souls, like the peasantry of the middle-ages, clustered around his rock fort, "Starved Rock," perched high as an eagle's nest. The region around he had begun to parcel out among his followers.

Feeling equal to the grandest enterprises, he had longed for liberty to beard the Spaniard in Northern Mexico. Having been granted that liberty, had he not been betrayed on his way back to the Mississippi, he would have made Starved Rock the strategic base of active operations against Mexicans. All the region between that post, styled St. Louis, and the South Sea, was subjected to him by his French commission.

Judging by such an experiment, and before the failures in this direction which followed hard after, it was not unreasonable to hope for founding feudal baronies far west with French retainers as benchmen of each dignitary, and a crowd of aboriginal vassals beneath all the whites; but supporting all by fur and farming in time of peace, and not less by filling the ranks in time of war. There still exists an early map of New France with a fort in every seigniory.

Enterprising Frenchmen, who aspired to the independence of a mediæval nobleman, must needs go west in order to find what

they sought. No populous native tribes still survived east of Lake Huron. The French were hemmed in by the English and Iroquois on the south, while short days and long winters repelled them from the north. On the other hand, everything allured them westward — natural highways, mild climate, fertile soil, prairies that needed no clearing, buffaloes fancied ready to yield wool and draw the plow, friendly Indians, and — more than all — elbow room, safe from Canadian dictators. The founders of Montreal had been brow-beaten in Quebec. The vice-governor at Montreal was not very subordinate to the royal functionary at Quebec, but more so than the officials upon Ontario and further were to his own jurisdiction. They were their own masters.

In addition to this, French intrigues in the far west were multiplied and intensified by pecuniary interest. Nothing but political supremacy in that distant realm could assure prosperity in that fur-trade where lay their sole hope of money-making.

As soon as they had secured sway in any tribe they first said, "Bring all your fur to our factors!" This point gained, their second demand was, "Make your neighbors do likewise, peaceably if you can, but forcibly if you must." Thus it came to pass that many a brave was butchered to procure beaver for French whose policy was that of Æsop's monkey:

> "That cunning old pug everybody remembers,
> Who, when he saw chestnuts a roasting in embers,
> To spare his own bacon, took pussy's two foots,
> And out of the ashes he hustled his nuts."

Considerations such as these show how powerfully the finesse of political schemers and the ambitions of feudalism roused the French to penetrate into the utmost corner of the west.

The English also, as adventurers, traders, or both, tried to push into the farthest western wilds. But the French outstripped them, arrested their factors and explorers and treated them as outlaws. The motto of the French was:

> "It shall go hard,
> But we will delve one yard below their mines
> And blow them at the moon."

The French foundations in the Northwest proved failures. When French officers gazed at the charge of the six hundred at Balaklava, they cried out: "This is admirable, but it is not war." So French foundations in the Northwest were wonderful beyond all wonder, but they did not constitute a state, one whole body fitly framed together, which vital in every part cannot but by annihilating, die.

The first foundation was Fun. Fun taken in homeopathic doses is good, but it is by no means substantial food for a life-time much less for a nation's life. At all events it either finds or makes frivolous those to whom it is all inall,— labor and not merely luxury,— business as well as recreation. If all the year were playing holidays, to sport would be as tedious as to work. Savage life, however fascinating at a distance as to the novelist Cooper, or the sentimentalist Rousseau, loses romance when viewed close at hand as by Parkman domiciliated among Dakotahs — indeed by the sober second thought of any one capable of appreciating civilization and aspiring to progress.

The result was that French fun-lovers, either like Nicolet returned from their sportive sallies to dwell among their own people as well as educative and elevating institutions, or on the other hand, they sunk to the low level of the aborigines around them, perhaps degraded them still lower by the vices of civilization. The backwoods maxim proved true; that it is the hardest thing in the world to make a white man out of an Indian, while it is very easy to make an Indian out of a white man.

The apostles of *faith* also failed in the far west. Their want of success was due in part to the extermination by war and plague of tribes among whom they ministered, in part to inability to reclaim other tribes from nomadic habits, and in part to the nature of their teachings. Their exhibition of Christianity was rather spectacular than intellectual, more emotional than practical. Among their maxims I find these: "It is God's will that whoever is born a subject should not reason but obey." "Teaching girls to read is robbing them of time." They taught singing but not reading. No newspaper appeared in New France till after the British conquest. At an Indian college which had flourished

for a generation Frontenac, relates that no student could speak French. In spite of all pains pupils proved Calibans on whom nurture would never stick. Of one that was taken to France at a tender age, baptized, and learned French well, I read that when brought back to Canada as an interpreter, he became as rude a barbarian as any one and held fast his barbarism to the end.

If the Jesuits had had free course on our Upper Lakes, the result would have been nations submissive but not self-sufficing, peaceable but unable to defend themselves — having the *personnel* of men but the puerility of children. They had an ordinance to hasten the *physical* weaning of Indian children — but their mental weaning they would never permit.

Frontenac's report to the home government was: "The Jesuits will not civilize the Indians because they wish to keep them in perpetual wardship. Their missions are hence mockeries." They censured La Salle because at his fort he had some fifty Indian children taught to read and write.

Compared with the sturdy Puritan, the self-reliant Yankee, the products of Jesuit training would seem those legendary monkeys who were intended to be men, but whose creation being begun on Saturday afternoon, was interrupted by the coming on of the Sabbath, so that they were sent into this breathing world scarce half made up. Their development remains arrested still. Well is it said: "A man to BE a man must feel that he holds his fate in his own hands."

However Jesuits might have succeeded, in blowing up a bubble, bright and polished as glass and iridescent with rainbow hues, it must have burst at the first rude shock from without, as did the insubstantial pageant which they conjured up in Paraguay.

A heretic would say that their system had not truth enough in it to make a lasting lie. Hence it was, "The perfume and suppliance of a minute."

The *fur-trader* rejoiced in a longer success than either the votary of fun or the apostle of faith. But *his* occupation too was gone at length. Fur-bearing animals vanished even sooner than the forests that sheltered them.

Fish began to be taken in Canadian waters before the first furs

were trapped on Canadian shores. The fish continue now as multitudinous as ever, while the fur is no more found. Five and a half millions have we recently paid for the right to fish in Canadian waters.

Crops springing out of the bosom of the earth are exhaustless like a living spring. Beasts wandering over its surface, or living in its dens, pass away, like desert streams in summer, and what is worse, are never renewed as those streams are.

Beaver Dam as the name of a city in Wisconsin may always endure, but the cunning handiwork of the beaver, chief favorite among fur-bearers, is to day scarcely discoverable in all the State. The beaver's gone beyond redemption, gone with a galloping consumption. Not all the quacks with all their gumption, will ever mend him.

The chief Yankee staple was fish; that of the French was fur. The contrast between the races was palpable. Accordingly the natives named the Yankees *Kinshon*, which signifies "fish," and the French *Onontio*, that is, "Big Mountain." The latter name may have been suggested by Gallic pomposity. But after labors manifold the mountain brought forth a mouse, and the fish swallowed him.

The victims lured on by falsehood or false fancies in pursuit of a short cut to the farthest East, were no less heart breakingly disappointed than the men of fun, fur and faith.

Their chase in the West of an ever-fleeing East, reminds me of De Soto chasing the phantom of a rejuvenating fountain. Both long roved in a fool's paradise, but at length wasted sinewy vigor, like thirst-parched pilgrims, running after the mirage when the sultry mist frowns o'er the desert with a show of waters mocking men's distress.

But after all both achieved great discoveries, like alchemists, not of what they sought, but of whatever was to be found. De Soto discovered the lower Mississippi, and French visionaries the upper, its head-waters, the Yellow Stone and the Rocky Mountain backbone of the continent. They were the first who ever burst into our inmost shrines.

But their aims were *low*. At its best their ideal was not to

found nations circled by all that exalts and embellishes civilized life. It was merely to discover a thoroughfare to the Pacific and the Indies ready made to their hands. This ideal was never realized, and under the old regime of the French it never could be.

To make such a pathway, or rather more than royal highway was a beau ideal reserved for the Anglo-Saxon of our times, and his ideal was straightway actualized,— the firstlings of his heart became the firstlings of his hand. Some of us cannot worship the heroes of our trans-continental roads. Even we, however, must admit that but for their iron will we should even now rejoice in no iron ways.

Indians and French — path-finders like Fremont — were a vapor that appeared for a little time — at most an Indian summer.

Yankees brushing them away, working mines of lead and lumber, and then extracting agricultural wealth yet more perennial and wide-spread, have built on firmer foundations, and are efflorescing in a higher style of culture throughout all departments of life.

The French who occupied the Northwest either as missionaries among Indians, and those bound by vow to celibacy, or who adopted Indian ways of life, naturally proved a race no less ephemeral than the natives themselves. They vanished all the sooner because they entered that region in small numbers. Indeed French immigrants were nowhere numerous in America.

But had one single feature of French policy been different, the change in American history would have been great beyond calculation. Huguenots, the only class of Frenchmen ready to leave *France*, were not permitted to enter New France. Had they been welcome there, legions of them would have penetrated its wilds as far as any fanatical Jesuit or jolly rover. They would have outnumbered the English Americans, being driven abroad by worse persecutions at home. They would have furnished material for such agricultural and manufacturing centers on the Upper Lakes as La Salle vainly strove to found in Illinois.

In the next place, most of those French refugees who enriched Switzerland, Holland, Germany, England, and divers British colonies, especially those on the Atlantic coast, with new arts or old

ones plied with new skill, would have betaken themselves to Canada. There no strange language nor strange institutions repelled them. They never willingly expatriated themselves, and in New France they would have seemed still at home. It has not been enough noticed that New France was at first founded by French Protestants, and that the early adventurers thither were of the same faith, as well as that outfitters being Calvinists would not admit Jesuits into their ships. Next, the two religions for a time there held divided empire. When a priest and a minister there died on the same day, they were laid in the same grave. "Let us see," it was said, "whether they who have always lived at war will now lie in peace." The first petition of Jesuits that "reformed religionists," so-called, should be forbidden to inhabit Canada dates from 1621. Rejected at that time by the French king it was granted six years afterwards.

Had such been the French foundations in our Northwest, they might still have stood strong there. The Canadians, while scarcely a tithe of the English, held their own for a century. What if they had surpassed them in numbers, as much as they did in unity, military spirit, and friendship for the aborigines?

In all likelihood France and England would to-day hold divided empire throughout the territory embraced by the United States. The settlers,— each race afraid of the other,— would both have clung to their mother countries, and sought protection under their wings. During the Napoleonic wars, instead of being developed by the carrying-trade of Europe,— by a market there for all our products, and by dedication to the arts of peace, we colonists should have been all the while belligerents,— and that between two fires, pierced by invasions from the west, while our coast was ravaged and our ports bombarded.

Not a few in this audience are of Huguenot descent. Their ancestors in all colonial wars must have fought against those British provinces for which in fact they fought.

Even if the colonies,— English and French,— had one or both of them become independent, each race would have forced the other to maintain a standing army of European proportions, to build a Chinese wall, or line of forts — "the labor of an age in

piled stones," — from the Upper Lakes to the Gulf. Border collisions would daily occur. Wars must have been frequent and chronic.

Again, had the French centuries ago burst into the Northwest by thousands instead of by scores, they would have planted their mediæval institutions too deeply to be rooted out. Lords of broad domains would have monopolized the land. Under them would have been vassals uneducated save to drudgery or death-dealing, not one in a thousand of them rising above the low level of that inglorious throng in which they were born. The Texan question of a witness, "Do you write your name like a monk, or make your mark like a gentleman?" would have been common all the way from the tropic to the pole.

The masses would have remained clannish retainers of hereditary chiefs. Each seigniory would have been a section cut out of France with all the pre-revolutionary enormities carried over ocean and continent like the angel-borne holy house of Loretto, and set down in the Mississippi Valley with all its imperfections on its head.

Even that earthquake revolution which toppled to the earth the feudal fabrics of France, would not have extended into the heart of this continent. It was, in fact, powerless even on the lower St. Lawrence, so far as not reinforced by British thunder.

On the whole, had Huguenots been tolerated from the first in New France, a million of them would have migrated there, and its population would have been no less numerous or puissant than that of British America. All the European colonies in America would probably still be subject to their parent states.

At all events they would have so balanced each other, and their mutual relations would have been so antagonistic, that the rise, progress and world-wide influence of those institutions and that form of society which are distinctively American, would have been impossible. America would have been Europeanized. There is no room in the universe for both Christ and Belial. So there was no room in these United States for both freedom and feudalism.

Well then may we thank God for the intolerance of Louis

XIV, or rather for the passing-pleasing tongue of Madam Maintenon, which kept that *Grand Monarque* her unconscious servitor. Though he meant not so, neither did her heart think so, their policy was suicidal. They were pioneers clearing the ground for the undisturbed establishment and expansion of a system — political, religious, educational, social,— which was ordained by God, and utilized by man, for revolutionizing not only America, but France and Europe. May that system of ours pervade the world, endure forever, and prove a survival of the fittest!

In our northwest French and Indians have stamped their names forever on many natural features,— lakes, rivers, mountains, and on hamlets which have, or will, become cities. But, while names are French and Indian,— as Chicago and St. Louis,— all else,— all distinguishing characteristics bespeak the Anglo-Saxons. They came out from Great Britain in order to build on a broader basis a Britain yet greater, continental and cosmopolitan, gathering together in one those whom Babel scattered abroad. Hence it has come to pass, that in the world's wide mouth, we to-day are called, not New French, nor yet New English, nor by the name of any Europeans whatever, but *Americans*, now and forever Americans. That cognomen is already all our own, and this fact I hail as an omen that the continent also in all its length as well as breadth will be ours ere long;

"THE UNITY AND MARRIED CALM OF STATES."

APPENDIX.

The following notes and strictures on the preceding paper have been sent me by Benjamin Sulte, Esq., of Ottawa, Canada, who is in many respects the most learned investigator known to me in matters relating to the early French in Canada.

I am happy to supplement my own studies by his aid. Into whatever inaccuracies he shows me to have fallen, I am quite sure that his general views correspond with my own.

It will seem to some readers rather strange if no one of those early French had been a convict — so that New France was an Eden as free from serpents as Ireland was ever fancied to have been rendered by St. Patrick.

M. Sulte says:

Champlain visited himself all the parts of Canada he could reach, and sent all round — especially in the direction of the west — as many young men as he could engage in the enterprise, in order to have them rendered familiar with the language, the habits of the Indian4, and the geography of the country. These efforts of Champlain, from 1609 to 1634, are most remarkable. He really formed a class of men, usually called interpreters, which is quite different from the one you allude to (the *coureurs de bois)* and which stood alone with the Jesuits, on the broad field of discoveries up to 1660, when the other class *(coureurs de bois)* began to exist. Thus, you have put together two different periods quite distinct from one another.

Now, as regards Nicolet's enterprise towards the Wisconsin region. He simply acted under Champlain's orders in this case, the same as he had done since 1618. There can be no two explanations of the motive that determined his trip of 1634. Champlain in this was following his old plan of discovery and alliance with the Indian tribes.

I wish also to state that the settlers of New France were never chosen from amongst the convicts of old France. Not a solitary case of that nature can be proven. We have the most abundant archives and records on the subject of the origin of the French Canadians that any colony can show. From Louis Hebert, the first settler, who came in 1617, to 1700, when immigration thoroughly ceased, every man is recorded in full and the descendants of these settlers still contine to correspond with the branch of the family remaining in France. If convicts ever came, they must have been hired by the companies who had the monoply of the trade — but I don't believe merchants were ever so foolish as to do that. I defy any one to prove a single case of a convict brought to Canada to settle there. If you possess any document on the subject, be sure you have something new on hand,— because no such affirmation has yet been maintained with proper authority. It must also be borne in mind that the settlers, or *habitants*, or French Canadians, as they are called, formed a population separate from the classes engaged in the fur trade or any other trade. It is a great mistake to intermix their history. Settlers had nothing to do with anything else but settling the country; they are the *only* group of Frenchmen that have resisted all hostile influences up to now,— the others have long disappeared. It is true, the settlers' sons have often turned to be *coureurs de bois* and engages of the trading companies, but this was to the detriment of the habitant community, i. e., directly the contrary of what so many historians have said about this question. Far from being an ancient vagabond, the settler was *invariably* a farmer that came from France purposely to establish his family on a farm in Canada. Unfortunately, the recruiting of young men, afterwards, from the country places of Lower Canada, for the purpose of trading in the west, paralyzed the little colony to a great extent. M. Parkman, whose appreciations are so seldom correct, says that the colony (1685) was living on the trade carried on with the Indians! What a stupid idea! Such trade was really killing the colony. The fields were

abandoned by the farmers' sons in the hope that they could make their fortunes in the woods. The monopoly destroyed the colony. The habitants never were in favor of it; they always complained of its results; but what could they do under the absolute and tyrannical system of Louis XIV. and the scandalous government of Louis XV.?

Did you ever put this question to yourself: What are the present French Canadians; where do they come from? Here is the whole question.

The French Canadians are purely and solely the group of farmers that came from 1617 to 1700, by small bands, under the direction of agents called seigneurs, but who were nothing more nor less than agents of colonization, and men of energy wishing to settle with their families in the new country. That group is distributed as follows:

4,000 men taken from farms in France.

1,000 men from regiment of Carignan Salière.

1,500 women that came with their husbands.

2,500 women selected by good authority and sent here to marry with settlers.

In all no more than 9,000 souls.

These people lived on their land and never meddled with the French group of officials, military men, public servants of all sorts, traders, etc. They formed the resident population. They alone remained in Canada. They are the French Canadians, whilst the others were mere Frenchmen. It is a general mistake of historians to confuse these two classes.

The settler, the habitant, the French Canadian, in brief never begged for help from France, except in the shape of troops (1637–1665) to chase the Iroquois, and in the shape of more settlers (1666–1688) to augment the colony. All the complaints in the Govenor General's letters mentioned by Mr. Parkman bear on those Frenchmen not settled in the country. Those were the begging class — the same class that ran away at the conquest (1760) to find a refuge in France. The settlers never regretted them! This accounts for the facility which the English enjoyed during the first ten years (1760–70) in the administration of the country.

Allow me to observe, also, that Champlain had only three men with him when he ascended the river Ottawa in 1613.

You seem to have no conception at all of what was the Canadian feudal system. The paragraph (page 55) in which you make allusion to it is so completely out of the real facts that I cannot but think that you have read Parkman, who is full of such efforts of imagination. It is true that English writers are always copying each other when they speak of Canada of old. The only sources of history for the period in question are written in French; then study them in the original, and not in the books of fanciful writers who have probably never completed the study of the proper documents. Does any English writer know that the French-Canadians possess 500 volumes about their own history, besides the enormous manuscript archives at their disposal? Mr. Parkman is clever enough to make his readers think he dis-

covered the documents he mentions, but the truth is that he merely ran his fingers through the 500 volumes in question — half of the time copying full pages of them without giving credit to the author.

I am not astonished at that. The province of Ontario, close to that of Quebec, is not at all enlightened about the French race in Canada. Newspapers and books are published there every day that are a repetition of falsehoods destroyed fifty times within a century. I was reading last week an article about "ignorance concerning the French-Canadians," published twenty miles only from the French province. No wonder that the Americans, who are located still further from us, are so completely informed on our subjects.

Speaking of the northwest, you mention our establishments here. The fact is that the French trading company had fur trading houses from 1721 to 1753 in that direction; they withdrew their men at the time of the conquest (1760). Those that remained there were partly Frenchmen of France, partly French-Canadian coureurs de bois. From 1760 to 1783 they lived with the Indians. In 1783 the "northwest" company was founded, and these men got hired by them for the trade. The first four white women who were sent to the Red River with their husbands, about 1810, saw no cultivation there. I don't see that we could speak about a colony which never existed. The only French colony worth looking at was the one established between Quebec and Montreal — and that one is still in existence. All the rest is a matter of trade, discoveries, missions, etc., quite distinct from the agricultural colony.

For want of light on the ensemble of the question — *all* the English writers resort to their imaginative power to explain what has taken place amongst us in the past,— and strange to say they don't even understand the present time

Coming back to Nicolet, I must not forget to tell you that in 1634, there were hardly one hundred people in the colony — all told, counting Frenchmen of all sorts possible. Out of that number, we have the names of Nicolet. Margry, Godefrey, Hertel, Marsolet, Brulé, and two or three others, who were interpreters. Seven or eight others were employes of the trading company called the Hundred Partners. Real, actual, true settlers were altogether about forty souls — say 7 or 8 families.

The *Feudal System* of Canada was practically a mechanism for colonization and it worked to the satisfaction of all parties interested. It lasted in full force from 1627 to 1854, without creating any conflict of importance. Its spirit so admirably adapted to the circumstances of the country and the necessities of the times, especially from 1626 to about 1700, is not understood by English-speaking writers generally, but here, in Canada, we know better.

A *seigneurie*, measuring six miles in front by six or twelve in depth, was granted to any man willing to bring settlers from France at his own expense, and provide them during a reasonable time with the requirements of their new situation. These seigneurs were all, with very few exceptions, men of pretty good family, but none of any high position, except now and then one

like Bishop Laval, who resided here and could superintend affairs through an employe engaged for that purpose.

In round figures, 159 of those seigneurs obtained lands between 1626 and 1760. Five or six of them were high officials in the colony; seven or eight officers discharged from their regiments — the rest (130 or more) men who did not rank with the noblesse in France and who looked to Canada as a country where they could build a future for themselves. I wonder at the imagination of Mr. Parkman when he speaks of the Canadian seigneur fresh from the court of Paris or Versailles! I wish he would name those who ever met with the splendor of "le roi-soleil!"

These men were full of courage and the spirit of enterprise. The very fact of trying to make a living in Canada and to rise to a higher situation here than in their mother country, speaks loud in their favor

They were under obligation to establish settlers on their seigneuries at a certain rate per annum. For this purpose, they recruited in the villages where they were best known in France, young farmers with their wives and thus formed in each seigneurie a fac-simile of the group left at home. From 1626 to 1662, each seigneurie was governed after the particular code of law (coutume) adopted in the part of France which they came from. In 1664, the *Coutume de Paris* was extended over all the colony. Each settler was given a lot measuring three or four acres[1] in front by forty deep. In this manner the road from Quebec to Montreal was quickly open for use in all sea ons — because the narrowness of the land made the houses close to each other, and instead of having a village — a continuous street of 180 miles in length was obtained. The king remonstrated against this arrangement — he was in favor of villages — but the "habitans" never listened to his objections. They knew better.

The seigneur was the first amongst the pioneers, the first to attack the forest the first in the field with the plow. After three years, a settler needed no more assistance. From that moment, he was able to pay his "redevance" to the seigneur. His taxes were partly in money, but more often "en nature" — the whole amounted to about $7 or $10 per annum, — all included, except what he had to give the miller when using the mill belonging to the seigneur — namely, the 26th part of the flour produced. A seigneur who was the recipient of $2,000 was a wonderfully rich man. Most of them never received more than $700 or $800 per annum.

They were representatives of the people as their seigneurs at Quebec and elsewhere when required. Their interest was so closely connected with the welfare of their retainers that no better system of "deputation" can be conceived, and mark that the laws concerning the administration of seigneur's were not in the hands of the seigneurs. Far from that, these laws were greatly in favor of the tenants. The consequence is that the seigneurs very seldom got the better in their contests with the farmers. These laws, interpreted from time to time by the King's ministers, always ran this way: In the beginning the seigneur is a father to his clausmen, because he and they

[1] By acres *arpents* each of 180 French feet are probably meant. J. D. B.

left France together after a long acquaintance, to seek a home in Canada. But the sons of the seigneurs might turn to be of a different stamp, and we must have a check on them.

When a tenant wished to have a lot for himself or his sons, he could select it, and the seigneur had no power to prevent it, nor to tax the lot more than the usual rate.

The administration of justice was a simple affair. The judge of the seigneurie was appointed by the seigneur, subject to the approval of the Governor General, and as the habitants had free access to this high official though their "syndics" and "capitaines de milice," every party was consulted before action was taken."

When the judge of the seigneurie had rendered a judgment, there was an appeal to the Justice of the Province in which the seigneurie was situated, *i. e.* Quebec, Three Rivers, or Montreal — and from there to the *Conseil Souverain* of Quebec, presided over by the Governor General. You can see that the seigneur had only the "basse" justice, and that that even was subject to appeal. As for "moyenne" and "haute" justice, although some seigneurs can show the words in their parchments, it was never exercised by them.

The seigneur was not necessarily a warrior, as Mr. Parkman so pompously describes him. Most of the seigneurs never troubled themselves with war. The militia organization was a separate affair. Some seigneurs' sons did mix themselves with the militia, but all they knew of military science was picked up in hunting on the paternal domain. That class of men became an annoyance after 1675 or thereabouts. They threw themselves into the woods and became the famous *coureurs de bois* or outlaws. They led other young men — sons of habitants — into that dissipated life.

By the time when settlers ceased to arrive from France (say 1690) the above vagabonds were a subject of much displeasure in the seigneuries — and most of the seigneurs had become very poor, owing to the inconsistency of the administrators of the colony who had brought the whole of the inhabitants under the thumb of the mercantile companies. Then the seigneurial power began to die, because the country passed virtually under the officials, traders and the like who had no other ambition than to make money and oppress the colony for that object.

In brief, the feudal system of Canada was so much liked that nobody thought of asking for its abolition before 1853, when Upper Canada agitated the question. Even now, it exists in many parts of the Province of Quebec, because it is useful there to this day for the purpose of colonization.

If the English House of Commons had not rejected the petition of the twenty counties in the eastern townships peopled entirely by English and Scotch emigrants, who, as late as 1828, wanted to adopt the French Canadian feudal system, these counties would have remained English. In fact, they have been conquered by the French-Canadians whose system of land tenure is far better than the English for a country like Canada, still sparsely settled.

THE PHILOSOPHY OF F. H. JACOBI.

By Prof. W. C. Sawyer.

Nothing is quite so real to an animal as the food he eats and the bed he sleeps upon. We are all animals and something more, but there is a popular tendency among us to cherish the grossness of the animal, and to smother and starve the heaven-born part that struggles for recognition through perceptions more ethereal than the animal knows, and longings that the animal cannot feel and that material things can never satisfy.

Assured that the meat by which man really grows is not that which nourishes the body, we do well to sit at the feet of those masters who offer to guide us out of this thralldom to the physical, and open our eyes upon the less palpable, but no less real, world in the midst of which we so unconsciously walk; for

> "The spirit world is not locked up;
> Thy feelings are closed, thy heart is dead."
> —Goethe's Faust.

F. H. Jacobi has the distinguished merit of establishing against Kant the following point: The "Critique of Pure Reason" denies that any casual nexus can be found between thinking and any noumenal object or subject, while the "Critique of Practical Reason," ignoring the principle already laid down, boldly assumes the transcendental as revealed by the phenomenal. Kant attempted to find some impossible demonstration for that which is undeniable and needs none, and thus threw a character of uncertainty upon the most positive knowledge that we have.

The work entitled "Divine Things and Their Revelation," was Jacobi's last, and probably contains the best exposition of his distinguishing doctrines, especially his "faith-philosophy." For this philosophy its author never claimed a place beside other systems, but, perhaps even too hastily and modestly, granted the argument to philosophers whose conclusions were revolting to him, but whose methods seemed to him valid. He thus occupied

an anomalous position, which must be explained in one of these two ways, namely, either Jacobi was in error in supposing that the head positively demanded pantheism and the heart Christianity, or we are constituted with a cruel and irreconcilable antinomy, waging perpetual war in the center of our being, and setting one member against another in a manner for which no development theory can account, and of which no beneficent Creator could be guilty. This is the most important error of which Jacobi can be convicted, as he himself clearly saw. He was fully aware that his doctrines must break into two opposed systems, one of which must be false, by the most positive principles of logical opposition.

An antinomy may well lie under the suspicion of being nothing more than a convenient name under which to cover the short-sightedness of men. Can God's laws conflict? or can it really be that both the affirmative and negative of any given proposition can be supported with equally strong proofs. By any given man, perhaps they may. In a boys' debating club they often are; but even the boys usually think that, if they knew all, the scale would promptly turn to one side or the other. With what reason, then, do men talk of antinomies as soon as the *pros* and *cons* seem to balance? It is clear that the data upon which rests one of the conflicting judgments must be either inaccurate or inadequate, unless there is a fallacy in the logic.

A supposed conflict of laws is sometimes attributed to the error of applying reason to matters beyond its sphere, as though there were spheres where reason could mislead, or where it were better, forsooth, to be unreasonable. Both Locke, in his "Essay Concerning the Human Understanding," and Kant, in his "Critique of Pure Reason," have given expression to views of which this would be a bald, but perhaps not altogether unfair, statement. Not the excess, but the deficiency, of reason leads to error; and laws which really conflict must be human. The Creator of the macrocosm created also the microcosm, and "I doubt not through the ages one increasing purpose runs." Rob the world of the faith that all things fit into the harmonious plan of the Author of all, and the philosophy of history, and the grand system of correlated sciences, which thrill us with enthusiastic delight as they

unfold before us, would, like bright dreams or punctured bubbles, vanish from the earth. All forms of matter, and all the faculties of the mind, must be supposed to be governed by harmonious laws, and enter, as co-ordinate elements, into the plan of the universe; else we impeach either the power, wisdom, or goodness of God.

Jacobi's philosophical creed developed at a time when the prevailing philosophy was Kant's, with all the admiration that belonged to its freshest triumphs. No other theme was so prominent as that to which, a century earlier, Locke had drawn very general attention — the question of the powers and limitations of the human understanding. After making experience the basis of all our knowledge, Locke was so unfortunate in his explanation of the origin of our ideas that Cousin easily convicted him of laying an excellent foundation for that sensationalism for which Hobbes and Condillac acknowledged their indebtedness to him, however distasteful such thanks might be.

It may not seem unnatural that Hobbes should derive from Locke's representative theory of perception his subtile corporeal spirit to replace the second member of Descartes' dualism, but it is far more startling to find Bishop Berkeley, with "every virtue under heaven," establishing upon the same basis a thorough-going idealism, and successfully maintaining his ground against the whole sensational school. To exhaust the strange possibilities of the case, Hume, again, accepting both Locke and Berkeley, advanced one fatal but inevitable step further, and, consigning mind to the same fate that matter had suffered at the hands of Berkeley, established a skeptical nihilism, which no subsequent philosopher has been able to refute without revising the whole foundation of the system upon which it rested. This task called for the genius of a Kant. He was able to reconstruct the principles of knowledge upon the ruins to which Locke's system had been reduced by the twofold *reductio ad absurdum* of Berkeley and Hume. In doing so, however, though he gained the foremost place among the metaphysicians of his age, he committed an error hardly inferior to Locke's, and quite as difficult to throw off. Locke perceived only images of things, that, so far as he could show, might

have no corresponding external objects behind them. Kant, on the other hand, perceived only phenomena, and knew nothing of the things in themselves, which are manifest only in the phenomena. For both alike objects were implied as the originals of the images of the one, and as the principals behind the phenomena of the other. Both alike have furnished a basis upon which logical minds have built up systems that have violated the plainest dicta of common sense. Every body but a few philosophers thinks he knows that he walks in an actual physical world, and among other men like himself, while, according to Locke and Kant, pure reason teaches nothing of the sort; but rather that the world which we see is within us, and that we may be dreaming as truly in our waking as in our sleeping hours. Goethe appreciates this situation very well when he makes Faust say that this philosophy leaves him "as great a fool as he was before;" and then, in despair of knowing anything, turn to the sensual enjoyments of the world.

From the particular error of Locke philosophy has largely, but not altogether, recovered; and from Kant's it is slowly recovering. To this end Jacobi has contributed the earliest and best assistance, by showing that sensation testifies not more positively of the so-called secondary qualities of bodies than of their objective actuality, as will be more fully shown in the proper connection.

But Fichte contributed toward the correction of Kant's error in a way similar to that in which Berkeley had exposed the weakness of Locke. Fichte inquired whether it was true that an actual objective world caused the subjective phenomena, as Kant evidently assumed. In his investigation of this problem he found in his consciousness the sensation, and from these inferred the objective, not in the relation of cause, but as the effect or product of the active mind. He accordingly gave a confident negative to his own query, and adopted the full consequence of the error in the central doctrine of his philosophy — that "all cognition is a self-activity which perceives only its own self-activity."

When Schelling replied to Fichte's reasoning, that we might with equal propriety reverse his process, and suppose the sub-

jective to result from the objective, then the claims of both to priority were recognized as equal; and both Fichte, in his latter days, and Schelling, admitted that an absolute existence underlies all phenomena.

A very important further modification of the philosophy of knowledge was achieved by Hegel, and still attracts great attention. He united the subjective and the objective into such a union that the latter was implied in the former. The phenomena which we perceive were regarded as having the same character objectively as subjectively. "The ground of their being," said Hegel, "is not an unknown essence immediately behind the phenomena, but the absolute idea." Thus constituted, absolute idealism makes a radical contrast with the subjective idealism of Fichte.

This system of Hegel, first offered for publication in Jena, during the bombardment of that city by Napoleon, is a little later in its origin than the faith philosophy of Jacobi; nevertheless, Jacobi is, in a certain sense, the representative of an elementary form of the latest philosophic thought. What the philosophy of the future is to be, no man can confidently tell; but it may not be too bold to predict that what Jacobi felt, but dared not say he knew, will yet find many to recognize its philosophical validity.

The chief claim of Jacobi to recognition among philosophers rests upon his doctrine that we have a direct intuitive knowledge of the suprasensible — that we see it with the "reason" as truly as we see physical objects with the eye. This doctrine has usually been regarded as enthusiastic, and its author sometimes set down among the Mystics of Germany. The degree of reproach implied in the terms *enthusiastic* and *mystic* varies with the persons who use them. When enthusiam is charged as equivalent to fanaticism, and mysticism as implying obscurity and error, they simply beg the question at issue. A legitimate enthusiasm is what Jacobi claimed; and if we translate the Greek elements of the word (ἐν θεός) as "God within," the meaning is rescued from all implication of error. Fanaticism is as far from the best sense of enthusiasm as rage from anger — to borrow a simile from Voltaire.

The quest of philosophy has ever been, before all else, for the efficient cause of nature. This cause does not appear in the nebular hypothesis, or in the atomic theory; for science cannot account for the first movements of either. Locke did not find it, for he had no secure hold upon anything objective. Kant did not find it in the pure reason, for pure reason could know nothing of any thing in itself. Jacobi found a first cause, he was sure, but only in his heart — there was not quite room enough for it in his head. He claimed that this, together with some other knowledge, is impressed upon the soul without the intervention, in any way, of physical organs. The philosophy of Locke does not willingly admit any impressions upon the *tabula rasa* of the mind apart from the products of sensation and their combinations. Jacobi's claims must, accordingly, be positively refused, or some of the principles abandoned which have been maintained, or tacitly admitted, by a multitude of philosophers. The *tabula-rasa* simile has been convicted of fault in the implication that the mind is a cold and dead slate, that simply holds, without addition or change, whatever is committed to it. If this were so, there would be for us no external world — all primary qualities of matter would be forever shut out of the mind, for no sensation ever resembled any one of them. Secondary qualities are purely subjective. They not only do not resemble in the least their immediate physical causes, but even these do not reside in the bodies to which we refer the qualities as by instinct, while the inferred concause, which *is* in the body, is beyond the reach of our investigation. It must be, then, that we are indebted to certain original energies of the mind for all that we know of the external world, even after sensation has revealed all that in the nature of the case is possible,

Kant insists upon the testimony of sensation as essential to the validity of mental products. Jacobi insists that he sees a light, which to the physical eye is invisible. Is he mistaken? or is Kant's requirement unessential?

A sensation is a feeling awakened in the mind through the medium of an organ of sense. This sensation becomes a perception when referred to the external object which occasioned it; thus do we acquire all our knowledge of the outward world. What,

then, are the essential elements in the formation of any perception? Before all, something must be impressed upon the consciousness. Sensations depend solely upon the nerves to convey them to the conscious subject. Any interruption of their career toward the brain puts an end to them, or rather, there being no sensation in the consciousness, none exists anywhere. If, therefore, sensation is essential to perception, then nerves are likewise essential. But nerves are only the menial organ which serves mysteriously to convey impressions to the mind, without, in ordinary perceptions, revealing themselves to the consciousness. Some perceptions, moreover, such as the perception of relations, are generally recognized as being independent of all sensation. So, too, causation, time, and identity, must be perceived, if at all, without the help of any mechanism, since in their nature they are impalpable. No particular character in the object, therefore, can be pronounced essential to mental perception; immaterial principles are perceived as clearly as granite hills.

It thus appears that the practical objective conditions which now limit perception may be purely casual. Only two elements remain which can be shown to be essential in the perception of all things objective. These are feeling and reflection; feeling, because it is the condition of both sensation and consciousness, and whatever is not felt in either of these ways cannot in any manner make itself known; and reflection, because feeling is not thought, and no knowledge can result from feeling simply as feeling, any more than we can become cognizant of a present physical object without looking upon it to discover its qualities. Reflection interprets feeling into terms of thought. This is done spontaneously, to be sure, and seems to attend rather than follow the feeling — what obviously follows being inference rather than intuition.

Both these essential conditions being met, the source or cause of the feeling does not affect the validity of the consequent perception. The feeling itself is sufficient evidence of the *actuality* of its cause; its *nature* is a distinct problem. "Whoever says he knows," observes Jacobi, "we properly ask him whence he knows. He must then depend at last upon one of these two things, either upon sensation or upon soul-feeling." All knowledge resting on

the latter Jacobi denominated "faith," and he doubtless enjoyed the same assurance of his "faith" as of his material possessions. Yet it was Jacobi who cast upon this assurance the reproach of being unphilosophical. That reproach commends the modesty of the philosopher more than his logical powers. It must be set down as his weakness that he dared not maintain as legitimate the firmest convictions of his soul, simply because the method by which he reached them was not philosophically orthodox in his day.

The best use of philosophy is, doubtless, to regulate human conduct; and that which is unphilosophical should accordingly be abandoned. Why not, then, abandon every thing which is given us by the intuition of reason and from no better source? Why not give up the notion of an external world? Simply because the universal conviction of the race makes it impossible. Men do not wait for the formal decisions of philosophers upon questions which find uniform answers in their own clearest intuitions. No contradiction of this decision would command their respect. Again, why not abandon the notion of a First Cause presiding over the universe and governing it according to the intelligent determinations of an unrestrained volition? The answer is to the same effect as the former, Because all races and tribes under the sun hold some faith in a god to whom they are responsible and expect to give account. The argument from common consent must not be despised. Philosophy cannot ignore it without itself being rejected. It rests upon intuitions which are universal and necessary, and which no authority is competent to gainsay.

Jacobi allows a logical validity to the pantheism of Spinoza, but it affords no satisfaction to the desires of his soul. His spirit rejects pantheism, while his reason accepts the demonstration on which it rests. His spirit, on the one hand, clings to the "faith," which his understanding cannot approve. Fully conscious of this paradox, Jacobi declared, "There is light in my heart, but when I attempt to bring it into my understanding, it goes out." What loyalty to the conclusions of a syllogism built upon false premises and doing violence to the strongest and purest intuitions of the soul! A weaker "faith" would have surrendered to so strong

a conviction of the demands of the understanding. A stronger logical faculty would have scorned the ambiguous position which Jacobi under protest occupied. It may not be evident which was the weaker, his "faith" or his reason, but his preference between the horns of his dilemma was unmistakable and strong. The sphere of the simple understanding he plainly calls inferior, since it sadly disappoints the highest aspirations of which we are capable. These are satisfied in the intuitions of the divine, in which Jacobi realizes the highest of all possible objective revelations. To rescue these intuitions from the fatal monism of Spinoza, Jacobi deliberately sacrificed his philosophy, such as it was, in favor of his faith. From that moment he formed a marked contrast with Spinoza. The latter knew no personal God; Jacobi ever felt his presence and heard his voice. Spinoza knew no causes except as immanent in matter and necessary; Jacobi recognized a Final Cause, and was conscious of his own freedom, and of his own accountability. Spinoza consequently enjoys a passionless repose, fearing nothing and hoping nothing, and witnessing the dissolution of his body with a stolid resignation, regarding his decay as another proof of his brotherhood with the clod. Jacobi, however, quick with the pulsations of an endless life, stretching eagerly forward to catch glimpses of the dawning of the bright to-morrow of his soul's desire, is by no means satisfied with the realizations of this life, but is more than satisfied with its hopes.

With Fichte and his ideal projection of subjective images Jacobi felt considerable sympathy. Fichte's soul was quick to recognize the spiritual forces of the universe, but he did not perceive their objective character. At this point Jacobi resists again an apparently valid conclusion in the clear light of his own intuitions. He was sure he saw, in the moral order of the world, a Father's hand; Fichte saw only a reflection of his own volitional activity. Such intolerable consequences of the reasoning of his metaphysical contemporaries, Jacobi escaped by resorting to the oracles of a higher authority. "There dwells within us," he said, "a spirit sent immediately from God, constituting the most essential part of our human nature. As this spirit is present to man

in his highest, deepest, and most personal consciousness, so the Giver of this spirit, God himself, is present to man through his heart just as nature is present to him through his senses. No sensible object can so seize upon the mind and irresistibly prove itself real, as those absolute objects, the true, the good, the beautiful, and the sublime, which can be seen with the eye of the spirit. We venture the bold speech that we believe in God because we see him, although he cannot be seen with the eye of this body." This spiritual vision is quite as clear as the physical; it is attended with no less feeling immediately produced in the soul, than comes to the soul through the office of the outward eye. It is not the eye that sees, but the soul by means of the eye. Such seeing is mediate, while Jacobi, if he sees God at all, must see him immediately, with no Moses and no organ of sense to stand between. Actual perception is not denied to sensation when it is referred to its cause. Who shall dispute that this intuition of an invisible Deity possesses at least as high claims to the character of a real perception as the sensations, exposed as they are to the defects of the physical body? May not the intuition even have some advantage, in the certainty of the objective existence over mediate knowledge, at least to the subject of it?

Sir William Hamilton maintains that in intuition cognition is given unconditionally as a fact, while, in all representative perception, the cognition is problematical. Should it be objected that Hamilton assumed, in the intuition of which he speaks, that the mind is conscious of only its own modification without relation to any object beyond the sphere of consciousness, it might be sufficient to show that Jacobi's claims find ample [illegible] realization under the careful definitions of this [illegible] losopher. We do not understand Jacobi to claim that his [illegible] itions reach to a cause, which, as perceived, is [illegible] but rather that this knowledge is simple, [illegible] Hamilton himself says, "nothing beyond the [illegible] by that which k[illegible] that which is known." This [illegible] ness of necessi[illegible] reach out and take hold of the [illegible] but if the ex[illegible] piritual in its [illegible] itself [illegible] ense, so [illegible]

its approach to the center of thought and feeling. Accordingly, Jacobi can say that "God himself is present to man in the heart," and that the human spirit contains "a shadow of the divine knowledge and will."

In this light we can understand our philosopher's meaning when he maintains that man reveals God, while nature conceals him:

> "But is it unreasonable to confess that we believe in God, not by reason of the nature which conceals him, but by reason of the supernatural in man, which alone reveals and proves him to exist? *Nature conceals God;* for through her whole domain nature reveals only fate, only an indissoluble chain of mere efficient causes without beginning and without end, excluding with equal necessity both providence and chance. . . . *Man reveals God;* for man, by his intelligence, rises above nature, and in virtue of this intelligence is conscious of himself as a power not only independent of but opposed to nature, and capable of resisting, conquering and controlling her. As man has a living faith in this power, superior to nature, which dwells in him; so has he a belief in God, a feeling, an experience of his existence."

This doctrine is perfectly consistent, as Jacobi claims, with the criticism of Kant, though it cannot be harmonized with the doctrines of Spinoza. Indeed, Kant's demonstration that the pure reason finds no certainty in practical things, not only admitted but even called for Jacobi's doctrine of a direct intuitive cognition of things-in-themselves. This intuition tramples upon the mechanism theory of the universe, and, rising above the defects of demonstration, gazes boldly upon the revealed face of the one great Cause that reason had long ago declared to be immanent in all forms of being and becoming.

This noblest function of the soul Jacobi did not uniformly denominate "faith," especially in his later writings. This term was too liable to be understood to imply a blind, irrational belief on the mere authority of others. To avoid so great a misconception of his doctrine Jacobi used the term "reason" (*Vernunft*), meaning, not the logical faculty, but the power to perceive directly in contrast with the understanding which is confined to the range of the demonstrable. The term "faith," therefore, when used by Jacobi, implied the surest possible kind of knowledge, but a knowledge which in its very nature cannot be communicated to

another by a syllogistic method. This is why the light in the heart was quenched when brought into the understanding. That light conveyed the divine image, which in the order of nature must be felt in order to be known. We cannot always describe what we have seen with our natural vision; much less can we expect to impart to another the first fruits of our spiritual seeing. The Apostle Paul said it was not lawful to utter the things which were revealed to him when "caught up into paradise." Similarly, doubtless, it is unlawful — *impossible* on account of the disabilities of our nature — for a man to formulate and communicate to another all of the religious experiences of his heart, even after they have so entered into his being that torture and death cannot induce him to deny them. This is the philosophy of the believer's testimony, daily declared in the sanctuary and daily disputed in the mart, "I *know* that my Redeemer liveth."

Owing to a lack of this experience the unbelieving naturally question the legitimateness of this faith, or at least ask the believer to prove a necessary connection between the mental phenomena on which he rests his faith and any objective cause. Suppose we make a similar demand of themselves. Can they show any necessary connection between the best established facts in science and any objective cause? All knowledge hangs upon a chain, some links of which are hidden, so that, without the exercise of a large practical faith, no science would be possible. When we trace the phenomena involved in a single perception of an outward object through the eye, we are charmed with the delicate offices of different parts of that organ; but when the light, in obedience to optical laws, has painted a beautiful inverted image of the object on the fine tissue of the retina, the physical phenomena of vision can be traced no further; they cease or disappear as motion, or physical change, and re-appear at once as intellectual perception — something which bears no discoverable resemblance to any of the physical phenomena of seeing. The chain of causes in all perceptions goes out of sight, some links are hidden.

According to Lotze,[1] "We shall never be able to prove that it

[1] Mikrokosmus, vol. i., p. 161; Leipzig. 1856.

lies in the nature of any motion . . . of itself to cease as motion and be reproduced as illuminating brilliancy, as sound, or as sweetness of taste." The motion here referred to is the sensible or physical part of the phenomena of sensation. The causal nexus between a wave, whether in the eye or in the air, and the mental conception of light, no man has ever discovered, but the scientist and the philosopher alike, together with universal humanity, accept with a practical assurance that cannot be shaken the testimony of their consciousness to the objective reality of the things perceived through any organ of sense. In unscientific terms, then, we may say that we know the things within reach of our senses because we *feel* them.

Feeling is the function of all the afferent nerves, and in some mysterious way we hear, taste, see, etc., by feeling. All the mechanism of our organs of sense is necessary to bring the physical within the grasp of the spiritual. By the aid of this mechanism we feel, as science insists, not the object, but some quality of the object appropriate to the sense in exercise. The universal consciousness, however, will have it that we feel *a body* thus and thus conditioned or qualified. Science says we feel the broad waves of light, or, practically, the redness of a physical body. Consciousness maintains that we see a *red body*. It is hazardous to quarrel with universal consciousness. Moreover, it would be unreasonable to reject, concerning the character of the phenomena, the testimony of the only authority by which its actuality had been, or could be, established. We *dare* not, therefore, banish the physical universe from our philosophy; we *cannot* banish it from our consciousness. God himself, in fashioning us so that we are thus compelled to recognize in our daily lives an objective universe, has involved his own veracity in the validity of these intuitions of our consciousness.

If we admit, as we seem forced to, that mind and matter can communicate, while their natures are so very unlike, much less should it be thought incredible that mind should be able to convey thought to another mind of the same nature. No mechanism can simplify or explain the perception of the physical; it simply makes it mysteriously possible. The same intuitional power that

magically reveals to us a physical universe and enforces its acceptance may similarly discover the Cause of the universe and enforce a belief in that Cause. This it does, and no human race is known that has not some notion of God.

Clearer and more full than this universal faith are the direct revelations to the spiritually minded, who, like Socrates and Jacobi, seem to have found a shorter way to the knowledge of God than through the regularly accredited prophets. This personal inspiration seems to resemble, in the strength of the conviction which it carries, that instinct which Kant has denominated "the voice of God." Brute instinct is concerned with nothing but what is essential to the well-being of the species. All this it fails not to supply. Birds know how to build nests, but they do not know how they know, or what principles require them to build as they do. Men no more about the instincts that supplement reason in their own species. God supplies whatever is out of reach that is essential to any of his creatures. In endowing man with a soul God fixed upon him another necessity quite as urgent as the preservation of his body, namely, the preservation of his soul. The Creator is, then, under an equal, or still greater, obligation to supply whatever is demanded by the interests of our spiritual nature. It is not unreasonable, therefore, that we should listen for the voice of God in a new revelation. Jacobi and millions more say they hear it. They find revealed in it the Almighty and an endless life. They *touch*, as it were, the suprasensible, and *know* it by a sort of spiritual empiricism. They are profoundly convinced. The demonstrations of the spirit are irresistible, but if denied, they can no more be forced upon a skeptic than the axioms of geometry.

We cannot too highly applaud the opinion of Victor Cousin, that "the error of Jacobi's school was not to see that this truth-speaking enthusiasm is only a purer and higher application of reason, in such manner that faith has its root in reason." This "enthusiasm," in the mouth of Cousin, suggests no reproach, but rather implies a reason which flies while the syllogism creeps. It must be conceded also that this slower method is, by its very nature, debarred from ever demonstrating the infinite, and thus

solving the most essential problems of religion and philosophy; for by the syllogism we can advance to no conclusion except through a more general conception. The term which must thus be included under another cannot contain the Deity, or satisfy the conditions of monotheism. The Highest, therefore, cannot possibly be reached through formal reasoning, and some other resource must be depended upon for this necessity of the soul. Nothing but Jacobi's intuitive cognition can yield the personal apocalypse of God.

When the clear testimony of consciousness is universally recognized as valid, then not only will Jacobi command an unqualified respect among philosophers; but objective science, as well as religion, will find a rational foundation, and, according to the claim of Drobisch, we shall realize in the philosophy of religion "the key-stone of the philosophical arch."

THE *Ἅπαξ Λεγόμενα* IN SHAKSPERE.

Omnia rara præclara; ipsa raritate rariora.

By James Davie Butler, LL. D.

When we examine the vocabulary of Shakspere what first strikes us is its copiousness. His characters are countless, and each one speaks his own dialect. His little fishes never talk like whales, nor do his whales talk like little fishes. This impression of mine grows stronger when I read in the Encyclopedia Britannica; "the language assigned to each character is made suitable to it, and to no other, and this with a truth and naturalness which the readers and spectators of every following age have recognized." Those curious in such matters have espied in his works quotations from seven foreign tongues, and those from Latin alone amount to one hundred and thirty-two.

Our first impression that the Shaksperian variety of words is multitudinous is confirmed by statistics. The titles in Mrs. Cowden Clarke's Shaksperian Concordance, counted one by one by a friend have been ascertained to be more than twenty-four thousand. The total vocabulary of Milton's poetical remains is more nearly seventeen than eighteen thousand (17,377); and that of Homer including the hymns as well as both Iliad and Odyssey is scarcely nine thousand. Five thousand eight hundred and sixty words exhaust the vocabulary of Dante's Divina Commedia. In the English Bible the different words are reckoned by Mr. G. P. Marsh in his lectures on the English language, at rather fewer than six thousand. Renan's estimate is 5,642. The number of titles, however, in Cruden's Concordance has been found to be greater by more than a thousand, namely 7,209. Those in Robinson's lexicon of the Greek Testament I have learned by actual count to be about five thousand five hundred.

Some German writers on Greek grammar believe they could teach Plato and Demosthenes useful lessons concerning Greek moods and tenses, even as the ancient Athenians, according to the fable of Phaedrus, undertook to prove that a pig did not

know how to squeal so well as they did. However this may be, any one of us to-day, thanks to the Concordance of Mrs. Clarke, and the Lexicon of Alexander Schmidt, may know much concerning Shakspere's use of language which Shakspere himself could not have known. One particular as to which he must have been ignorant, while we may have knowledge, is regarding his employment of *Ἅπαξ λεγόμενα.*

The phrase *Ἅπαξ λεγόμενα*, literally "once spoken," may be traced back to the Alexandrine glossographers centuries before our era, who invented it to describe those words which they observed to occur once, and only once, in any author or literature. It is so convenient an expression for statistical commentators on the Bible, and on the classics as well, that they will not willingly let it die. The synonomous phrase *Ἅπαξ εἰρημένα* is also a favorite with some Germans, but if we accent it according to its Greek accents, it is hard to pronounce, and I accordingly eschew it. So does Autenrieth in his Homeric dictionary.

Style is modified by the presence of such words — a moment bright, then gone forever. Greek critics were early sensitive to this subtle influence on style and therefore catalogued those words which produced it.

The list of *Ἅπαξ λεγόμενα*,— or words used once, and only once, in Shakspere, is surprisingly large. Those words are more than any man can easily number. Nevertheless I have counted those beginning with two letters. The result is that the *Ἅπαξ λεγόμενα* with initial A are 364, and those with initial M are 310.

I have no reason to suppose the census with these initials to be proportionally greater than that with other letters. If it is not, then the Shaksperian words occurring only once cannot be fewer than 5,000, and they are probably a still greater legion.

The number I have culled from 146 pages of Schmidt is 674. At this rate the total on the 1,409 pages of the entire lexicon would foot up 6,504. It is possible then that Shakspere discarded, after once trying them, more different words than fill and enrich the whole English Bible. The old grammarians said their term *supine* was so named because it was very seldom employed, and therefore was almost always lying on its *back*. The supines of Shakspere outnumbered the employes of most authors.

No notices of Shaksperian *Ἅπαξ λεγόμενα* had come to my knowledge when my attention was first called to that theme. In the midst of my investigation, however, I observed a statement in the London Academy (No. 402, p. 48) that some English scholar had counted no less than 549 words in the single play of Henry V. that are no where else discoverable in the Shaksperian dramas. It may also be worth noting that the first line which Shakspere ever wrote, or at least published, namely:

"Even as the sun with *purple-colored* face,"

contains a compound which he thenceforth and forever refrained from repeating.

The multitude of Shaksperian *Ἅπαξ λεγόμενα* appears still more surprising if we compare it with expressions of the same class in the Scriptures and in Homer.

In the English Bible the *Ἅπαξ λεγόμενα* with the initials A 69 and M 63 are in all one hundred and thirty-two, to 674 under the same initials in Shakspere. These Biblical terms would be more than twice as many as we find them if as numerous in proportion to their total vocabulary as his are.

The Homeric *Ἅπαξ λεγόμενα* with initial M are 78. But if as numerous in proportion to Homer's whole world of words as Shakspere's are, they would run up to 186; that is, to more than twice as many as their actual number.

In the *Greek* New Testament I have counted sixty-three *Ἅπαξ λεγόμενα* commencing with the letter M, a larger number than you would expect, for it is as large as that in the whole English Bible commencing with the same letter, which is also exactly sixty-three. This fact indicates in Paul and others who wrote the Greek Testament a wider range of expression thnn their English translators could boast.

The Shaksperian *Ἅπαξ λεγόμενα* with initial M.— which amount to over three hundred (310), I have also compared with the whole verbal inventory of the English language so far as it begins with that letter. To my surprise they make up almost one-fifth of that stock, which on the authority of the Nation (vol. XX, p. 345.) can muster only 1,641 words, with initial M.

You will at once inquire: "What is the *nature* of these re-

jected Shaksperian vocables, which he seems to have viewed either as milk that would bear no more than one skimming" or rather as "beauty too rich for use for earth too dear?" The percentage of *classical* words among them is great, greater indeed than in the body of Shakspere's writings. According to the analysis of Weisse, in an average hundred of Shaksperian words one third are classical and two thirds Saxon. But then, he adds, all the classical elements have inherent meaning, while half of the Saxon have none. The result is that of the significant words in Shakspere one half are of classical derivation.

Now of the *Ἅπαξ λεγόμενα* with initial A, I call 262 words out of 364 classical, and 152 out of 310 with initial M, that is 414 out of 674, or about four-sevenths of the whole host commencing with those two letters.

In doubtful cases I have classed those words only as classical, the first etymology of which in Webster is from a classical or Romance root. In the Biblical *Ἅπαξ λεγόμενα* the classical factor is enormous, namely not less than 69 per cent., while even in Shaksperian words of the same class it is no more than sixty-one.

Again, among the 674 A. and M. *Ἅπαξ λεγόμενα* the proportion of words now obsolete is unexpectedly *small.* Of 310 with initial M, only one sixth or fifty-one at the utmost are now disused either in sense, or even in form. Of this half hundred a few were used in Shakspere, but are not at present as verbs, as to *maculate*, to *miracle*, to *mud*, to *mist*, to *mischief*, to *moral.* Also, *merchandized* and *musicked.*

Another class, now rarely written, are *misproud*, *misdread*, *mappery*, *mansionry*, *marybuds*, *masterdom*, *mistership*, *mistressship.*

Then there are slight variants from our orthography or meanings, as *mained* for maimed, *markman* for marksman, *make* for mate, *makeless* for mateless, *mirable*, *mervailous*, *mess* for mass,—*manakin*, *minikin*, *meyny* for many, *momentany* for momentary, *misgraffing*, *mountainer*, *moraler*, *misanthropos*, *mott* for motto, to *mutine*, *minutely* every minute.

None seem wholly dead words except the following eighteen. To *mammock* tear, *mell* meddle, *mose* mourn, *micher* truant, *mome* fool, *mallecho* mischief, *maund* basket, *marcantant* merchant, *mun*

sound of the wind, *mure* wall, *meacock* henpecked, *mop* grin, *militarist* soldier, *murrion* affected with murrain, *mammering* hesitating,— *mered* only,— *mountant* raised up.

The Ἅπαξ λεγόμενα in Shakspere are often so beautiful and poetical that we wonder how they could fail to be his favorites again and again, for they are jewels that might hang twenty years before our eyes yet never lose their luster. Why were they never shown but once?

They remind me of the exquisite crystal bowl from which I saw a Jewess and her bridegroom drink in Prague and which was then dashed in pieces on the floor of the synagogue, or of the Chigi porcelain painted by Raphael which, as soon as it had been once removed from the table, was thrown into the Tiber. To what purpose was this waste? Why should they be used up with once using? Even the Greek drama that would never presume to let a God appear but for an action worthy of a God, was not so pervaded with horror of too much.

Some specimens of this class which all writers but Shakspere would have often paraded as pets, are such words as magical, mirthful, mightful, merriness, majestically, marbled, martyred, mountainous, magnanimity, magnificence, marrowless, matin, masterpiece, masterdom, meander, mellifluous, menaces, mockable, monarchize, moon-beams, motto, mundane, mural, multipotent, mourningly, etc.

About one-tenth of the remaining Ἅπαξ λεγόμενα with initial M, are descriptive compounds. Nearly all of them are among the following twenty-six adjectives: *maiden-tongued*, *maiden-widowed*, *man-entered*, *many-headed*, *marble-breasted*, *marble-constant*, *marble-hearted*, *marrow-eating*, *mean-appareled*, *merchant-marring*, *mercy-lacking*, *mirth-moving*, *moving-delicate*, *mock-water*, *more-having*, *mortal-breathing*, *mortal-living*, *mortal-staring*, *motley-minded*, *mouse-eaten*, *moss-grown*, *mouth-filling*, *mouth-made*, *muddy-mettled*, *maid-pale*, *momentary-swift*.

From this list, which is nearly complete, it is evident that such compounds as may be multiplied at will by a word coiner form but a small proportion of the words that are used once only by Shakspere.

Again, a majority of Shaksperian *Ἅπαξ λεγόμενα* being familiar to us as household words, and needful to us as daily food, it seems impossible that he who had cared to use them once should have need of them no more.

Some specimens, all with initial M, are the words, mechanics, machine, maxim, mission, monastic, mode, marsh, magnify, majority, malcontent, malignancy, manly (as an adverb), malleable, manna, maratime, manslaughter, market-day,-folks,-maid,-price, masterly, mealy, meekly, miserably, mercifully, mindful, memorial, mention, merchant-like, mercenary, memorandums, mercurial, meridian, medal, metropolis, mimic, metaphysics, ministration, to moderate, misapply, misconstruction, misgovernment, misquote, monster-like, monstrously, monstrosity, moneyed, monopoly, mutable, mor-ised, mortise, muniments, mother-wit.

The letter *M.*, which has been the staple of the present paper, is probably a fair representative of Shakspere's diction in regard to words which he would term "seld-shown." The subject, however, deserves to be treated more exhaustively. Every letter ought to be investigated as a single one has now been, and more abundantly. Nor would the labor be arduous, if the task were assumed by any Shaksperian club and divided among a score of its fellows, as the work of lexicography was among the forty members of the French academy. Such an examination would conclusively confirm, or confute, the conclusions to which the facts now set forth have led. It would also suggest others, and those of still greater interest.

In drawing up catalogues of once-used words, if such a set of co-laborers would append to each word the name of the play in which it occurs, the Shaksperian dramas could be easily compared in a manner which has never hitherto been possible. The *Ἅπαξ λεγόμενα* in each particular play would be readily drawn out in a table. Then it would at once become manifest how far the number of such words varied in different works, and whether it was greatest in the early, or middle, or latest period of Shaksperian productivity.

In a casual reading of Cymbeline and Henry VIII., more than three score words in each that are elsewhere unfound have struck

my eye, but more hundreds must have been passed unnoticed. Aside from the 549 once-used words in Henry V., already mentioned, I know not that such verbal statistics have been gathered. But they would not be without manifold utilities. They would aid in judging by style concerning the genuineness of doubtful passages. They would show how far Shakspere's alms basket of such words, which he calls "fire-new," continued to the last, like charity, which never faileth.

The array of once-used words which has been drawn up in the present writing must, as I think, surprise any one who passes them in review. The further one pushes research in the same line, the more his wonder will grow. Of compounds with the pre-fix *re*, like *reiterate* and *resignation*, he will discover one hundred and fifty lacking two, no one of which he will meet with again. To the same class of vocables undiscoverable a second time belongs every word in the line, "Unhouseled, disappointed, unaneled," as I have already stated, and the *italicized* words in the following phrases:

> "Horns *whelked* and *waved* like the *enridged* sea"
> "Massy *staples*
> And *corresponsive* and fulfilling bolts *sperr* up."

In the following nine lines, which are almost consecutive, the words in *italics*, numbering nine (or ten if we count *lash* which is no where else employed in the sense of the thong or cord of a whip), make their entrances and exits once for all.

> "In shape no bigger than an *agate-stone*
> Her *wagon-spokes* made of long spinners' legs,
> The cover of the wings of *grasshoppers*,
> The *traces* of the smallest spider's web.
> Her wagoner a small *grey-coated* gnat
> Her whip of cricket's bone, the lash a *film*.
> Time out of mind the fairies' *coachmakers*
> And sometimes comes she with a *tithe-pig's* tail,
> Then dreams he of another *benefice*."

And yet Romeo and Juliet, the play from which this passage is extracted, was among Shakspeare's earliest efforts. Though a prolific writer for twenty years afterward, he had no occasion for any one of these words even once again,— and repeated the phrase "time out of mind" only on one occasion.

Nowhere perhaps will the student of Shaksperian diction be more astonished than in observing how *uncommon* is the repetition of the commonest words. Who would anticipate that such vocables as the following would never do duty but once? *Fuller, shoemaker, straggler, playing, crazy, sisterly, scholarly, profoundly, prodigiously, wordless, comeliness, restful, fitful, forefoot, forecast, springhalt, rinsing, flannel, frock, sprout, leech, salamander, flail, flake, cater, corpulent, beverage, navigation, salary, omen, obscurity, cataract, cathedral, symbol, gospel, inwardness, Jesus, disciple, apostle, exhortation, homily, dirge, papist, institution, fragile,*— or such word-clusters as, *definite, definitive, definitively;* or these five sprouts from one root, to *elf, elvish, elvish-marked, elf-lock, elf-skin.*

No one class of once-used words is more conspicuous in Shakspere than *alliterative* compounds. This fact will be clear from the following very partial register of such formations: *all-abhorred, all-admiring, bow-back, burly-boned, bugbear, bull-bearing, bull-beeves, blood-bespotted, brow bound, bate-breeding, blood-boltered, bow-boy, baby-brow, care-crazed, cloud-capped, counter-caster, cain-colored, canvas-climber, child-changed, custard-coffin, chamber-council, death-darting, dew-dropping, death-divining, deep-drawing, drug-damned, dove-drawn, dismal-dreaming, double-dealing, double-damned, deep-drenched, dumb-discoursive, ever-esteemed, fast-falling, folly-fallen, foot-fall, faultful, fitful, fiery-footed, fleet-foot, full-flowing, forceful, fraudful, feast-finding, false-faced, foul faced, free-footed, filly-foal, full-fed, find-fault, full-fraught, glass-gazing, gain-giving, grim-grinning, guts-griping, great-grown, hard-hearted, hard handed, heaven-hued, heavenly-harnessed, heavy-hanging, heart-hardening, hell-hated, highly-heaped, hoary-headed, hollow-hearted, hydra-headed, honey-heavy, honest-hearted, harvest-home, king-killer, love-lacking low laid, lack luster, love-letter, lack linen, lack-love, lank-lean, lass-lorn, long legged, lily-livered, lazar-like, long-lived, lean-looked, light-o' love, peace-parted periwig-pated, proud-pied, pity-pleading, plume-plucked, pistol-proof, plot-proof, ripe red, riding-robe, riding-rod, surfeit swelled, cinque-spotted, sweet suggesting, saint-seducing, sober sad, sad-set, sea-salt, sea-sorrow, sea-swallowed, silver-sweet, sober-suited, still stand, ship-side, spirit stirring, super subtle, super-serviceable, sweet seasoned, summer swelling, summer steaming, sick-*

service, sly-slow, snail-slow, softly-sprighted, soft-slow, trumpet-tongued, tempest-tossed,, tongue-tied, true-telling, travel-tainted, virgin-violator, want-wit, water-walled, wave worn, war-worn, woolward, well-willer, well-won, water-work, wonder-wounded.

These words, and four or five thousand more equally excellent, which have been the golden language of the English-speaking world for three centuries since Shakspere, and which, belonging to the immortal part of their vernacular, will be so forever, we are apt to think he should have worn in their newest gloss, not cast aside so soon. Why was he as shy of repeating them as Hudibras was of showing his wit,

> "Who bore it not about
> As if afraid to wear it out,
> Except on holidays or so,
> As men their best apparel do?"

This question, why a full fourth of Shakspere's verbal riches was never brought to light more than once, is probably one which nobody can at present answer, even to his own satisfaction. Yet, the phenomenon is so remarkable that every one will try after his own fashion to account for it. My own attempt at a provisional explanation I will present in the latter part of this paper.

Let us first notice another question concerning the Ἅπαξ λεγόμενα, namely that which respects their *origin.* Where did they come from? How far did Shakspere make them, and how far were they ready to his hand? No approach to answering this inquiry can be made for some years. Yet as to this matter let us rejoice that the dictionary of the British Philological society is now near publication. This work, slowly elaborated by thousands of co-workers in many devious walks of study on both sides of the Atlantic, aims to exhibit the first appearance in a book of every English word. In regard to the great bulk of Shakspere's diction, it will enable us ten years hence to see how much of it was known to literature before him, and how much of it he, himself a snapper up of unconsidered trifles, gathered or gleaned in highways and byways, or caused to ramify and effloresce from Saxon or classical roots and trunks, thus endowing his purposes with words to make them known.

Meantime, we are left to conjectures. As of his own coinage I should set down such words as mirth-moving, merriness, motley-minded, masterdom, mockable, marbled, martyred, marrowless, mightful, multipotent, monarchize, etc., etc.

Professor Skeat, the most painstaking investigator known to me of early English, has discovered the word "disappointed" in no author earlier than Shakspere. Nor has Shakspere made use of that word more than once, namely in the line:

> "Unhouseled, disappointed, unaneled."

In that line all the words without exception are *Ἅπαξ λεγόμενα.*

The word "disappointed" is not employed by Shakspere in its modern meaning, but as signifying *unprepared,* or better perhaps *unshriven.*

But however much of his linguistic treasury Shakspere shall be proved to have inherited ready-made, whatever scraps he may have stolen at the feast of languages, it is clear that he was an imperial creator of language. Having a mint of phrases in his own brain, well might he speak with the contempt he does of those "fools who for a tricksy word defy the matter,"—that is slight or disregard it. He never needed to do that. Words were "correspondent to his command and, Ariel-like, did his sprighting gently." When has any verbal necessity compelled him to give his sense a turn that does not naturally belong to it?

It is very possible that Shakspere frequently shunned expressions he had once preferred and that because otherwise his style would become monotonous, and so cloy the hungry edge of appetite. According to his own authority, "when they seldom come they wished for come." And again:

> "Therefore are feasts so solemn and so rare,
> Since seldom coming in the long year set,
> Like stones of worth they thinly placed are,
> Or captain jewels in the carcanet."

In thousands of cases, however, Shakspere cannot have rejected words through fear lest he should repeat them. It has taken three centuries for the world to ferret out his *Ἅπαξ λεγόμενα,* can we believe that he himself knew them all? Unless he were the Providence which numbers all hairs of the head, he had not got

the start of the majestic world so far as that, however myriad-minded we may consider him.

An instinct which would have rendered him aware of each and every individual of five thousand words that he had employed once only would be as inconceivable as that of Falstaff which made him discern at midnight the heir apparent in Prince Hal, when disguised as a highwayman. In short, Shakspere could not be conscious of all the words he had once used more than Brigham Young could recognize all the wives he had once wedded.

In the absence of other theories concerning the reasons for the Shaksperian *Ἅπαξ λεγόμενα* being so abundant, I throw out a suggestion of my own, which may stand till a better one shall supplant it.

Shakspere's forte lay in diversified characterization, and, in my judgment, when he had sketched each several character, he was never content till he had either found or fabricated the aptest words possible for painting its form and pressure even in all *nuances* most true to life. No two characters being identical in any particular, more than two faces are, no two descriptions as drawn by his genius could repeat many of the self-same words. Each of his vocables thus became like each one of the seven thousand pieces in a locomotive which fits the one niche it was ordained to fill, but is out of place everywhere else, yes even *dislocated.*

The more his ethical differentiations, the more his language was differentiated. His personages were as diversified as have been portrayed by the whole band of Italian painters, but being a wizard in words he resembled the magician in mosaic who can delineate in stone every feature of those portraits, thanks to his discriminating and imitating shades of color more numberless than even Shakspere's words.

It is hard to believe that Shakspere's characters were born like Athene from the brain of Jove in panoplied perfection. They grew. The play of Troilus was a dozen years in growth. According to the best commentators, "internal evidence favors the opinion that *Romeo and Juliet* was an early work, and that it was subsequently revised and enlarged. Shakspere after having sketched out a play on the fashion of his youthful taste and skill,

returned in after years to enlarge it, remodel it and enrich it with the matured fruits of years of observation and reflection. *Love's Labor Lost* first appeared in print with the annunciation that it was "newly revised and augmented." It is now very generally regarded as a revision of a play which Shakspere had produced ten years before and named *Love's Labor Won.* Cymbeline was an entire *rifacimento* of an early dramatic attempt, showing not only matured fulness of thought but laboring intensity of compressed expression." This being the fact, it is clear that Shakspere treated his dramas as Guido did his Cleopatra which he would not let leave his studio till ten years after the non-artistic world had deemed that portrait finished.

Meantime the painter was penciling his canvas with curious touches, each approximating some fraction nearer his ideal. So the poet sought to find out acceptable words, or what he terms "an army of good words." He poured his new wine into new bottles, and never was at rest till he had arrayed his ideas in that fitness of phrase which comes only by fits.

Had he survived fifty years longer I suppose he would to the last have been, like Plato, perfecting his phrases. One couplet which as he left it reads:

> "Find tongues in trees, books in the running brooks,
> Sermons in stones, and good in everything,"

he might possibly have corrected and improved, as some commentator has done for him, so as to express more truth, if less poetry, making the words to stand:

> "Find *leaves* on trees, *stones* in the running brooks,
> Sermons in *books*, and *gain* in everything."

To speak seriously, "His manner in diction was progressive, and this progress has been deemed so clearly traceable in his plays that it can enable us to determine their chronological order." This view would have been accepted by Dryden, who treating of Caliban remarks: "His language is as hobgoblin as his person. In him Shakspere not only found out a new character, but devised and adapted a new manner of language for that character."

On first thought it may seem beneath Shaksperian dignity to be careful and troubled about verbal niceties. But no one will

continue so to think who has once perceived how much pains our dramatist takes in delineating every one of his fools, and that in showing forth their minutest follies he works by wit and not by witchcraft.

The result of Shakspere's curious verbal felicity, is that while other authors satiate and soon tire us, his speech forever breathes an indescribable freshness.

> "Age cannot wither
> Nor custom stale his infinite variety."

In the last line I have quoted there is a *Ἅπαξ λεγόμενον*, but it is a word which I think you would hardly guess. It is the last word,— namely, "variety."[1]

In order to make sure of the thing he refused to repeat the word. Indeed, he calls "iteration damnable."

On every average page of Shakspere you are greeted and gladdened by at least five words that you never saw before in his writings and that you will never see again, speaking once and then forever holding their peace,— each not only rare but a nonesuch,— five gems just shown, then snatched away. Each page is studded with five stars, each as unique as the century flower, and like the night-blooming cereus,

> "The perfume and suppliance of a minute."

The mind of Shakspere was bodied forth as Montezuma was appareled, whose costume, however gorgeous, was never twice the same, and so like Shakspere's own "robe pontifical, ne'er seen but wondered at."

Hence the Shaksperian style is fresh as morning dews and changeful as evening clouds, so that we remain forever doubtful in relation to his manner and his matter, which of them owes the greater debt to the other.

---

[1] Though this instance [Ant. and Cleop., 2, 2, 241] is the only occurrence of *variety* in the plays, we meet the word once more in Shakspere's poems, namely, in the twenty-first line of Venus and Adonis:

> "Making them red and pale in endless variety."

Not a few other words which appear once only in the plays, are also repeated in the poems. But it was the *ἅπαξ λεγόμενα* in the plays, and not in other Shaksperian writings, of which it was my aim to treat.

The Shaksperian plots are analogous to the grouping of Raphael, the characters to the drawing of Michael Angelo, but the word-painting exceeds the coloring of Titian. Accordingly, in view of Shakspere's diction, I would long ago have said, if I could, what I read in Arthur Helps concerning a perfect style, that "there is a sense of felicity about it, declaring it to be the product of a happy moment, so that you feel that it will not happen again to that man who writes the sentence, nor to any other of the sons of men, to say the like thing so choicely, tersely, mellifluously and completely." In the central court of the Neapolitan museum I observed grape-clusters, volutes, moldings, fingers and antique fragments of all sorts wrought in the rarest marble, lying scattered on the pavement, exposed to sun and rain, cast down the wrong side up, and seemingly thrown away, as when the stones of the Jewish sanctuary were poured out in every street. Nothing reveals the sculptural opulence of Italy like that apparent wastefulness. It seems to proclaim that Italy can afford to make nothing of what would elsewhere be judged worthy of shrines. We say to ourselves, "If such be the things she throws away, what must be her jewels!" A similar feeling rises in me while exploring Shakspere's prodigality in *Ἅπαξ λεγόμενα.* His exchequer must have been more exhaustless than the Bank of England, and he threw away more dies for coining words than the British mint ever possessed for coining money.

On the whole, in whatever aspect we survey the Bard of Avon I am reminded of the retired Boston merchant who, in his old age, reading Hamlet for the first time was enraptured. When asked how he liked Shakspere, his answer was, "How do I like him? *Like* is no word for my admiration. The truth is that not twenty men in modern Boston can write anything better than old Shakspere." I say ditto to the Boston man. Not more than forty men in Madison (the present company excepted) can produce plays superior to the old Shaksperian.

DEPARTMENT

OF

SCIENCES.

DEPARTMENT OF SCIENCES.

A LIST OF THE CRUSTACEA OF WISCONSIN.

With Notes on some New or Little Known Species.

By Will F. Bundy, M. D., Sauk City.

The crustacean fauna of Wisconsin has as yet received so little attention that it is at present impossible to present, with even approximate completeness, a list of the species inhabiting her waters. The various dredgings in Lake Superior under the auspices of the general government, and a dredging expedition off Racine previously reported to this academy by Dr. P. R. Hoy, have furnished almost our whole knowledge of the crustacean fauna of the lakes on our borders, while the interior of the state remains almost entirely unexplored. A species of cambarus (C. virilis) from Sugar river, another (C. propinquus) from Madison, and an amphipod, (Orchestes dentatus), from the latter place, are, I believe, the only crustaceans that have been accredited to the interior of the state till within a very recent period. That our streams and lakes are extremely rich in crustacean life, is abundantly attested by the fact that not a single locality has been explored with any degree of thoroughness without revealing the presence of several species of the higher genera.

The species included in this list, with the exception of those found only in the great lakes, were all taken within the comparatively limited area included in the counties of Racine, Jefferson, Dodge, Fond du Lac, Outagamie, Dane, Sauk and Richland. I have received specimens from but a single locality each, in the greater number of these.

The following list embraces all the species of the higher orders known to inhabit the waters of the state:

Order: Decapoda.

Family: Astacidæ.

Cambarus acutus. Girard.

C. stygius. Bundy.

C. virilis. Hagen.
C. propinquus. Girard.
C. placidus. Hagen.
C. rusticus. Girard.
C. wisconsinensis. Bundy.
C. debilis. Bundy.
C. gracilis. Bundy.
C. bartonii. Erichson.
C. obesus. Hagen.

Family: Mysidæ.

Mysis relicta. Loven.

ORDER: AMPHIPODA.

Family: Orchestidæ.

Orchestes dentatus. Smith.

Family: Lysianassidæ.

Pontoporeia hoyi. Smith.
P. filicornis. Smith.

Family: Gammaridæ.

Gammarus limnæus. Smith.
G. fasciatus. Say.
Crangonyx gracilis. Smith.

ORDER: ISOPODA.

Family: Assellidæ.

Asellus intermedius. Forbes.
Asellopsis tenax. Hagen.

ORDER: PHYLLOPIDÆ.

Family: Branchipodidæ.

Eubranchipus bundyi. Forbes.

Family: Estheriadæ.

Limnetis sp.?

The genus Cambarus is the only representative of the family Astacidæ in the fresh waters of the United States east of the Rocky Mountains. These animals, popularly known as "crawfish" or "crabs," are our largest crustaceans. The great number of species, separated by characters generally obscure and difficult of definition, many of them remarkably inconstant, with an undoubted dimorphism of males and the not infrequent occurrence of abnormal individuals, render the study of this genus particularly perplexing.

The following key will assist in separating the species herein mentioned:

A.—Rostrum toothed near apex, at least when young.

B.—Rostrum long, pointed; first abdominal legs of male truncate; third joint of third and fourth thoracic legs hooked.

C.—Hands long and slender; fingers curved; cephalothorax densely tuberculate. C. *acutus.*

CC.—Hands short; cephalothorax smooth or nearly so. C. *stygius.*

BB.—Rostrum subquadrangular; first abdominal legs of male bifid; hooks on third joint only, of thoracic legs.

D.—Tips of first abdominal legs of male nearly equal, straight or slightly curved; two rows of teeth on lower border of brachium *very indistinct* or *absent.*

E.—Rostrum carinated above. C. *propinquus.*

EE.—Rostrum not carinated above; hands large; fingers gaping at base. C. *placidus.*

DD.—Tips of first abdominal legs of male unequal and recurved.

F.—Margins of rostrum converging in front; first abdominal legs of male long, thick, inner ramus swollen near apex. C. *wisconsinensis.*

AA.—Rostrum toothless.

H.—First abdominal legs of male truncate; three slender teeth at apex. C. *gracilis.*

HH.—First abdominal legs of male ending in two short, thick, recurved teeth.

I.—Dorsal areola wide. C. *bartonii.*

II.— Dorsal areola none. C. *obesus.*

Cambarus acutus (Girard) has been found in Racine county by Dr. Hoy. It occurs also in marsh ditches near Sauk City in company with C. obesus.

C. stygius (Bundy). Bulletin No. 1, Ill. Mus. Nat. Hist., 1876.

A number of small crawfish were sent me by Dr. P. R. Hoy, by whom they were found on the shore of Lake Michigan at Racine, having been washed ashore during a storm. Proving to be a new species, they were described under the above name. The rostrum is long and pointed, smooth above, foveolate at base; cephalothorax slightly compressed, smooth or slightly punctate above and finely granulate on sides. The dorsal area is narrow and the lateral spines acute, antennal plates wide, truncate, with short apical teeth; epistoma rounded in front, twice as wide as long; third maxillipedes hairy on inner and lower sides; hands short, smooth, serrate on inner margins, fingers short, nearly straight, ribbed and punctate above, with contiguous margins tuberculate, outer one hairy; third segment of third (and probably fourth) thoracic legs of male hooked. (The specimens were so badly mutilated during the transfer through the mail that I could not determine this point, not one of the three males sent me having the fourth legs remaining.) The first abdominal legs of male are short, truncate, with three short obtuse teeth directed outward from posterior margins of apex, leaving a smooth groove passing up on outer surface between these teeth and the anterior margin. The ventral ring of female is flat, transversely elliptical, with posterior margin slightly elevated. This species resembles C. acutus, but can be instantly separated by the short hands and non-tuberculate annulus of female. The color of these specimens when caught was a dark cream, darker along sutures. In alcohol they changed to a purplish black, not confined to the exoskeleton, but extending to the adjacent soft tissues.

C. *viriles* (Hagen) is our most abundant species. It will doubtless be found in all the streams of the state.

A male in my collection, taken on a fisherman's net at Jefferson, belongs to Hagen's variety A. It is the largest crawfish I have seen, measuring 6¾ inches from tip of telson to that of ros-

trum. The specimen has peculiar hooks on third segment of second pair of thoracic legs.

C. *propinquus* (Girard) is also a very abundant species, generally found in company with C. *virilis*. It is our smallest species. Of hundreds in my collection from various parts of the state, the largest measures only two and one-fourth inches from tip of telson to tip of rostrum.

C. *placidus* (Hagen) occurs sparingly in Fox river, from which stream I have received a single individual.

C. *rusticus* (Girard) has been found in Lake Superior.

C. *wisconsinenis* (Bundy). Bul. No. 1, Ill. Mus. Nat. Hist., 1876. Rostrum wide at base, much narrower in front, not depressed, slightly concave above and nearly smooth, margins not elevated above eyes, acumen short; cephalothorax oval, punctate above and granulate on sides; lateral teeth but slightly developed; areola narrow, wider behind; antennæ slender, shorter than body; epistoma variable, wider than long, lateral angles prominent; third maxillipedes bearded within, and below at base only; carpus with a group of small sharp teeth on inner margin; two rows of teeth on lower aspect of brachium; third segment of third thoracic legs hooked; first abdominal legs of male long, thick, bifid, nearly straight, reaching when folded under thorax to base of first pair of legs; external ramus longer, with recurved tip, inner ramus swollen near short, acute, obliquely incurved apex.

Racine and Normal, Ill.:

C. *debilis* (Bundy). Bulletin No. 1, Ill. Mus. Nat. Hist., 1876. This crawfish was found in the Little Baraboo river at Ironton, in company with C. *propinquus*. A single individual was also found in the Wisconsin river at Sauk City.

Rostrum wide, quadrangular, slightly concave above, teeth prominent, margins nearly parallel, acumen short and flat; cephalothorax slightly depressed, punctate above, granulate on sides; lateral teeth acute; dorsal area narrow, widest behind; antennal plates somewhat longer than rostrum; antennæ slender, reaching to base of telson; epistoma wider than long, truncate; third maxillipedes barbate on inner and lower sides; hands with two rows of teeth on inner margins; contiguous margins of fingers tuber-

culate; costate and punctate above, outer one hairy at base; third segment of third thoracic legs hooked; first abdominal legs of male long, bifid, nearly straight, outer ramus longer, recurved, inner ramus more abruptly curved near apex, not enlarged near apex as in C. wisconsinensis; tubercle or inner basal angle small.

C. *gracillis* (Bundy). Bulletin No. 1, Ill. Mus. Nat. Hist., 1876. Rostrum short, wide, depressed, toothless, concave above, nearly right-angled in front; cephalothorax laterally compressed, smooth above, granulate on sides; areola wanting; cephalic carinæ prominent, ending behind in callosities; antennal plates very small and narrow; eyes small; antennæ short and slender; epistoma rounded in front; third maxillipedes hairy on inner and lower aspects; hands large, smooth below, punctate above, strongly toothed on inner margins; fingers slender, gaping at base, depressed, contiguous margins irregularly tuberculate, outer one incurved, wide at base, movable one longer, tuberculate on outer margin near base; carpus with one large and several small teeth on inner margin; brachium with two rows of sharp teeth on lower margin; third joint of third thoracic legs of male hooked; first abdominal legs of male truncate, with several small apical teeth, the inner one longest, slender and directed obliquely outward; bases of these legs narrow and inserted into deep sinuses in the first abdominal segment; interpedal space long, narrow, reaching half way from small basal tubercle to apex of legs.

The second form male has shorter, less gaping fingers, smaller hooks on third thoracic legs and articulated first abdominal legs.

The annulus of the female is movable, small and round. It consists of two half-rings, each of which embraces one end of the other. Two tubercules on the anterior border are separated by a slight furrow that widens behind, covering the posterior border.

It occurs on the prairies in the vicinity of Racine, where it was found by Dr. P. R. Hoy, to whose kindness I am indebted for specimens.

It is also found abundantly along water courses in early spring at Normal, Ill. (Prof. Forbes).

Dr. Hoy found it burrowing in low grounds on the prairies, emerging from its holes at nightfall and after rains.

C. *obesus* (Hagen).

This is one of our largest and most abundant crawfish. Unlike most other species, it prefers stagnant water, frequenting ponds and meadow ditches, often wandering far from bodies of surface water, burrowing in wet fields and swales.

It is pre-eminently our burrowing species, sometimes extending its hole to considerable depths. I once followed a burrow twelve feet without unearthing its occupant or reaching the bottom of the hole.

This species is easily identified. The rostrum is short, toothless, depressed, concave above; areola wanting; first abdominal legs of male bifid, with two short, thick, abruptly recurved teeth.

The annulus of female is transversely elliptical, symmetrical, anterior and posterior margins bituberculate; fossa 8 shaped, constricted in middle by anterior and posterier tubercles; lateral angles rounded.

C. *bartonii.* (Erichson.)

I do not think this species has been found in the interior of the state. It occurs in Lake Superior.

It is similar to C. obesus. The rostrum is not so much depressed, is less excavated above and the areola is very wide.

The female annulus has the posterior border elevated and the lateral angles acute.

Mysas relicta. (Loven.)

This occurs in the Great Lakes. It has not been found in the interior waters of the state.

Orchestes dentatus. (Smith.)

With the exception of *Gammarus fasciatus* this is the most abundant species in the interior waters of the state.

Pontoporeia hoyi. (Smith.)

P. filicornas. (Smith.)

Both of these species inhabit the deep waters of Lake Michigan. They have never been found in the interior waters of the state, but their occurrence in the deeper lakes is probable.

Gammarus limnæus. (Smith.)

Found in the Great Lakes. Dr. P. R. Hoy has found it in a clear spring brook near Racine.

G. *fasciatus.* (Say.)

This is doubtless the most abundant of our crustacea. I have not failed to find it, in greater or less abundance, in every stream or pool that I have examined. It is particularly numerous in small brooklets whose beds are covered with deposits of finely divided vegetable debris.

Crangonyx gracilis. (Smith.)

This species has not been found in the interior waters of the state. It occurs in Lake Superior, and Professor Forbes finds it in abundance in central Illinois.

Asellus intermedius. (Forbes.)

Abundant in stagnant sloughs and slow running brooks about Sauk City. These Wisconsin specimens differ from the types of Professor Forbes in several unimportant details, especially in the shape of the ramus of the first genital plate, and the size of the second joint of the inner ramus of the second plate.

Assellopsis tenax. (Hagen.)

This species I have not seen. It is reported from Lake Superior.

Eubranchipus bundyi. (Forbes.) Bulletin No. 1, Ill. Mus. Nat. Hist., 1876.

This, our largest phyllopod, was discovered in small ponds of surface water at Jefferson. It was found in abundance in April, but after a few weeks entirely disappeared. Specimens found in two neighboring ponds, while indistinguishable in other respects, differed markedly in size and coloring. In one of these ponds in a densely timbered lot they were small, and pale in color, while in a pond exposed to the sun they were much larger and brilliantly colored.

Limnetis (sp.?)

In company with the smaller Eubranchipides above mentioned was found an apparently undescribed species of Limnetis. have met with it in no other locality.

Dioptomus sanguineus. (Forbes.)

This beautiful little creature is an abundant inhabitant of the marshy pools and ditches near Sauk City.

THE CORALS OF DELAFIELD.

By Ira M. Buel.

The large collection of fossils made by the Geological Survey at Roberts' quarry, Delafield, Wisconsin, is surpassed in interest and scientific value by no other representation of Palæozoic fauna ever obtained from our state. It contains thousands of specimens almost perfectly preserved by the blue friable shale in which they were imbedded; and of the seventy species already distinguished, about one-half are new to science. The coralline representatives found here are of special interest to the student and naturalist.

The locality in question (Sec. 24, T. 7, R. 18 W.) lies on the southern shore of Pewaukee lake, and in the edge of a trough carved by glacial forces out of the lower layers of the Niagara limestone, and the soft underlying Cincinnati shales; the basin being occupied in part by the lake itself. By the removal of the limestone layers in the quarry, quite a surface of this shale was exposed, and as this formation somewhat resembles some of the Carboniferous shales, it was supposed by some inquiring mind to belong to that formation. A shaft was accordingly sunk at this point for the discovery of coal, and was not abandoned until a depth of fifty feet had been reached. The mound of rock and clay thrown out of this pit or shaft, the rain-washed monument of a geological delusion, was the source of all of the specimens obtained from that locality.

These corralline forms are all of small size, the smallest species measuring about an inch in length and about a tenth of an inch in diameter. The largest coral fragment is about two inches in diameter and consists of a sort of central base from which a number of slender arms branched out. Within these limits we find almost every possible variation in form, manner of growth, branching and surface markings.

The size, form and arrangement of cells and cell walls, are the principal distinguishing features of these corals; and as these features are mainly microscopic, the labor of identification of species and varieties among these thousands of specimens was not a small

task. The Polyp or Bryozoan cells seldom exceed a hundredth of an inch, and in some species are less than a two hundred and fiftieth of an inch in diameter. The cell walls and interspaces are often dotted with pits or pores, the tubuli of some authorities, or studded with granules, whose dimensions are from one-half to one-tenth of the diameter of the cells. In the illustrated drawings these surface markings are enlarged from twenty to fifty diameters.

The term *corals*, as applied to these forms, does not necessarily imply that they belong to the radiate sub-kingdom. We find, indeed, that Professor Dana includes under this general term calcareous or honey structures formed not only by Polyps and Hydroids (Radiates), but by Bryozoans (Mollusca), and also by certain low vegetable forms.

In the classifications that have been made, the widest diversity exists; no two authorities seem to agree, and the same species is relegated even to different sub-kingdoms by leading naturalists. Of the thirteen genera recognized in this collection, Professor Whitfield has placed *Chœtetes*, *Monticulipora*, *Stellipora*, *Alveolites* and *Dekayia* under Corals; and *Trematopora*, *Fistulipora*, *Palæschara*, *Stictopora*, *Fenestella*, *Retopora*, *Alecto* and *Aulopora* under Bryozoans. S. A. Miller, of Cincinnati, classes the first group as Radiates of the Favosite group, *Fistulipora* as a Millepore, *Aulopora* as an Alcyanoid coral, and the remainder Bryozoans. Professor Dana differs from others in considering the *Chœtetes* and related genera Hydroids instead of Polyp corals, while Dr. Rominger, of Michigan, throws them out of the Radiate sub-kingdom altogether, and places the whole list under Bryozoans. The close relationship and gradation of forms observed in our specimens indicate that they should not be separated into as widely differing divisions as has heretofore been done.

Before considering this matter further, we will notice the relationships that exist between some of these forms. Beginning with those genera that are considered by all authorities as belonging to the Bryozoan order of Mollusks, we first notice the two representatives of the genus *Stictopora*, that are found in this collection. (Fig. 1 represents S. elegantula, and Fig. 2 S. fragilis.)

The genus is thus described by Dr. Hall: "A foliaceous branching coral, supported by smooth rootlike expansions; branches bifurcating and sometimes coalescing, celluliferous on both sides, with thin central axis. Cellules, oval tubes, not enlarged below apertures, distinctly oval with raised borders, nearly as wide as the cells within.

The distinctive features of these species lie in the mode of branching, size, shape and arrangements of the cells. Their resemblance to modern Bryozoan forms is manifest. This resemblance is still more plainly seen in the reticulated forms represented by Figs. 3 and 4.[1] These are incrusting forms with the cells on

[1] These figures refer to drawings placed before the association at the presentation of this paper in December, 1878. Some of the corals will be illustrated in Vol. IV, Wis. Geol. Surv.

one side only. Fig. 3 is an undescribed species, referred to the genus *Retopora* by Professor Whitfield. Fig. 4 was described by Professor Whitfield, and his description is found in the annual report of the Wisconsin Geological Survey for 1877, p. 68, under the name *Fenestella granulosa.*

The more obvious characters of each form are as follows: The Retopora presents anastomosing branches with irregular, elliptical or linear, pointed meshes, upper surface of branches thickly covered with circular pores which are arranged in three or four longitudinal rows. In the Fenestella the branches do not reunite after separation, but frequently bifurcate and are connected at quite regular intervals by extremely narrow bars which divide the interspaces into oblong spaces or fenestrules. The pores in this form are arranged in lines, a single row on each margin of the branches or rays. The opposite surface of the frond is densely covered with very minute granules, hence the term *granulosa*, applied to the species.

Turning to those forms which more closely resemble living radiate corals, we notice first of all the delicately formed *Trematopora annulifer*, Whitfield, described in the Annual Report Wisconsin Geological Survey for 1877, page 67. Scores of fragments of this beautiful fossil are found imbedded in

the surface of some of the blocks of shale, and though their diameter is hardly larger than that of a knitting needle, their peculiar sharp annulations distinguish them at a glance. The surface pores are fine as needle points, yet under the microscope show in general an elliptical section and are separated by grooved walls giving to each opening a distinct margin or rim which is elevated into a sharp spine on the lower side. The genus *Fistulapora* exhibits a still further remove from the Bryozoan type. The larger cells in this series have plainly marked transverse partitions as in the Favosite corals. Still we have in some forms thin incrusting layers and masses built up by the superposition of these layers. Our collections contain several new species of this genus, two of which have been described. The two forms to which I wish to call your attention now are *F. solidissima* and *F. lens.* The surface markings in these species are nearly alike; the former presents solid, cylindrical or flattened stems, often branching, while the latter presents disk-like expansions with openings on one side only. The surface of the former shows very small elliptical cells, separated by comparatively thick walls or interspaces which are studded by minute pores arranged in one, two, or sometimes three rows between the cells. Twelve to sixteen of these larger cells are found in the space of an eighth of an inch, measured along the branches. In F. lens the cells are rather larger and the interspaces narrower; otherwise the appearance of the surface in these species is similar.

The forms already noticed are generally considered to be Bryozoans. The difference of opinion that has been referred to applies principally to the remaining forms, and at this point, therefore, we should look for some important fundamental distinctions.

The genus *Stellipora* stands nearest to those just noted, and, therefore, claims our attention. The beautiful form, S. polystomella, is one of our most common fossils: and although we obtain only fragments of its broad frond-like expansions, the star-like tubercles that stud its surface, when perfectly preserved, render it one of the most attractive species to the casual observer. Our species is identified with the form described by Nicholson in the Ohio reports, but presents some points of difference. This

author states that the number of rays found on these star-like prominences is from eight to twelve. Ours display from five to eighteen of these processes. The raised hexagonal border which he notes in the interspaces between the stars is shown in but a single specimen in our collection, and only imperfectly there. The star-like prominences in our specimens are much more irregular in form and arrangement, and the pores occupying the interstellar spaces have plainly-marked raised rims as in the genus *Trematopora* heretofore described.

Closely resembling this species in some of its forms stands a newly described species *Monticulipora punctata*, (An. Report, Wis. Geol. Sur. p. 71). This is a very variable form, especially as to surface markings. It is a cylindrical, branching coral, the stems varying from one-eighth to three-fourths of an inch in diameter. Some specimens display tubercular prominences very closely resembling those of the form last described; others show none of these raised figures. The surface of all specimens referred to this species is studded with non-cellular, minutely porous interspaces separated by surfaces marked by cells and pore-marked walls, just such as are shown by representatives of the genus *Fistulipora*. About these interspaces the larger cells are sometimes arranged in radiating lines or ridges. In these forms the resemblance to *Stellipora* is very marked to the unassisted eye. Under the lens, however, the arrangement of cells, cell walls and porous surfaces of cell walls and interspaces brings out the resemblance to the other genus just mentioned. The only marked difference between this form and those described as *Fistulipora* is the presence and prominence of the interspaces, and these are mentioned by Dr. Rominger, of Michigan, as characteristic of the latter genus. This author would doubtless place it at once under that genus.

We present also three other very closely allied forms of the genus *Monticulipora*. These are nearly alike in mode of growth, of branching, and in thickness of cell walls.

A detailed description of the first species will serve as a basis for all. Prof. Whitfield describes it as growing in strong, solid, somewhat flattened, frequently branching stems, covered with

rather prominent, rounded tubercles with concave interspaces. Cells polygonal, those on the tubercles not differing in shape or size from the others; ten to fourteen on the stem in the space of one-eighth of a linear inch. The cell walls are sharp, without intercellular pits or pores, but elevated at the angles so as to form low points. This description is abridged from that given by that eminent paleontologist on page 71, An. Rep't, before cited. *Monticulipora multituberculata* is the formidable name borne by this little fellow. *M. rectangularis* differs from this in the form and arrangement of cells; these are generally quadrangular, and are arranged in concentrically curved lines showing much the same arrangement as the engraved lines on the surface of a watch-case. The third form is almost intermediate between these two types in surface markings, but is of larger growth and has less prominent monticules. The pores are quite generally hexagonal and are arranged in straight or gently curving lines. This form is undescribed.

There is some doubt in my mind as to the existence of any constant difference between these three forms. The concentric arrangement of cells is sometimes observable at the ends of branches of *M. multituberculata*, and *M. rectangularis* does not always display this arrangement of pores over the whole surface. The elevated spiny angles which characterize the cell walls of the first named species are not always apparent, and are sometimes to be observed on the latter form. The undescribed form is too closely allied to the others to warrant a separate description or designation. The wide variation in form and features would seem to indicate that at most only varieties should be claimed for these forms. The genus *Chætetes* to which the four succeeding species are assigned was originally thought to include forms like the last, but its author described the increase of its cells as taking place by division. In most of the forms in which the method of increase of parts has been made out it has been found to be by a different process, and so the new genera *Monticulipora stenopora*, etc., were founded, and into these genera were gathered those forms that were found to disagree with the original genus in this respect. The most that we can say of some of these is that they are at

present classed under the old genus because they have not been proved to belong to any other genus, i. e., their manner of growth has never been discovered.

C. atritus, the first form noted under this designation, was first described in the Ohio reports. It is distinguished by the presence of small quadrangular, conical eminences, which are thickly scattered over the surface of the coral, especially at the flattened ends of the branches. The specimens from Ohio are described as cylindrical, frequently branching forms, from four to seven lines in diameter and eight to ten corallites in the space of one line. Ours are much smaller, from one and a half to three lines in diameter and flattened, with ten or twelve corallites in the space of a line. *Chætetes Jamesi*, described likewise in the Ohio reports, has its representative here also. The walls of the corallite cells in this form show the extraordinary thickness exhibited by the Ohio form, but also show a well marked groove upon their summit, a feature that is not noticed by Nicholson in his descriptions, nor shown in a type specimen which I have examined from that state. This feature has been before mentioned as a charac teristic of the Bryozoan genus *Trematopora*. *C. fusiformis* is a new species (see An. Rep't, '76, p. 70). This is a very minute form, less than an inch in length and an eighth of an inch in diameter. The cells are very minute, twelve to twenty in the space of a line. The cell walls are thick, sometimes with minute pores, sometimes with a well marked groove on their summits, and in other cases sharply ridged between the cells. The very close resemblance that exists between this form and *Trematopora annulifera* argues very strongly against their being placed in different sub-kingdoms. I have failed to find any characteristic in these two last species that should remove them from those of the genus *Trematopora*.

I desire also to call attention to some undescribed and perhaps previously unnoticed forms which I observed while classifying the collections of the state survey.

The first is a thin expansion found encrusting a fragment of a Brachiopod shell. The cells in this form are rather larger than those of any of the other species here noted, and seemed to be

formed by the grouping in various ways of beautifully trilobate semi-circular walls, after the manner of the fancy designs known by the ladies as shell-work. The appearance of the surface is more suggestive of modern Bryozoans than any other form. I should judge that it belongs to the genus Alveolites. Another well marked but undescribed fossil is doubtless a *Fistulipora.* The manner of growth of this form is various. It sometimes appears as an incrusting coral, sometimes grows out into thin fronds, again is found in irregularly-lobed masses, and occasionally takes the form of solid cylindrical branches. Its comparatively large cells, 6 to 8 in the space of a line, are elliptical in outline and have prominent thin walls. These cells are irregularly scattered over the surface, sometimes in contact but oftener separated by interspaces which are studded with smaller circular or polygonal cellules. These are of very unequal size and seem to have no systematic arrangement. The sharpness of outline possessed by cells and cellules in this form makes it one of the handsomest of these little curiosities.

From the facts observed during my examinations of these fossils, and especially from that portion which has been herein presented, the following conclusions have been drawn:

1. Throughout the whole series here represented we find no strongly marked lines of separation, but rather a group of forms bound together by many points of similarity.

2. These relationships preclude the possibility that we have here the representatives of two sub-kingdoms.

3. The close relationship borne by some of these corals to forms distinctly radiate would seem to indicate that they hold an intermediate position between the radiate and molluscan sub-kingdoms. It would be a hopeless task to attempt to establish their exact relationships from these fragmentary skeletons.

4. The extreme variability exhibited by the fossils themselves precludes the existence of well-defined genera and species, and points out an error in the past whereby these arbitrary distinctions have been unnecessarily multiplied.

5. The most careful study of extended collections is necessary to enable the observer to fix the few distinguishing lines by which

nature has herself classified this fauna, and even then we must not expect to find divisions, but rather connected branches of one central type.

The small collection hastily gathered by an exploring party from a little mound of debris must necessarily represent but a small proportion of the life that really existed in the teeming seas of that geological epoch. Amateur geologists have here a rich field for original work, and may find unlimited opportunity for study and investigation.

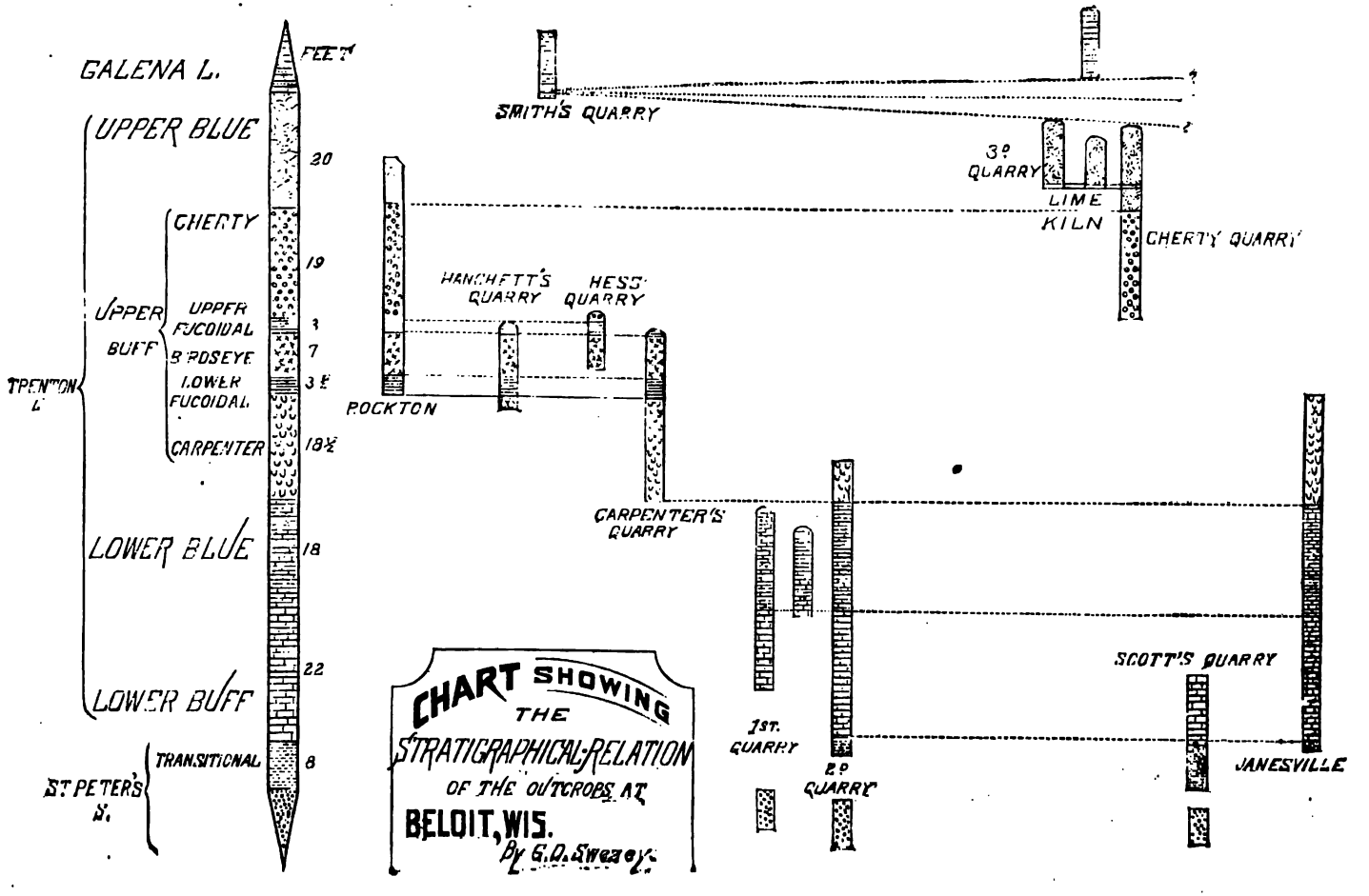
ON SOME POINTS IN THE GEOLOGY OF THE REGION ABOUT BELOIT.

By G. D. Swezey.

Along the line of hills which forms the western boundary of the Rock river bottoms at Beloit are exposed at frequent intervals the outcropping edges of rock strata; these include the upper layers of the St. Peters sandstone, the whole or nearly the whole thickness of the Trenton limestone, and the lower layers of the Galena limestone.

The Trenton limestone, which consequently most interests us today, is a formation which presents so much variation in lithological characters, and to some extent in fossils, that it is readily divisible into a large number of distinct subdivisions, whose characters are so well marked that they can in most cases be identified with ease, and sufficiently persistent, at least over the few miles of extent with which we have to do, so that they can be matched with a good degree of certainty; there is scarcely an exposure of any extent in the region of whose place in the Trenton section we have any doubt. Moreover it happens that of the one hundred and eleven feet of Trenton limestone, we have exposed in one or more outcrops of the region, every layer unless it be a few feet in the horizon of the Upper Blue.

The subdivisions of our Trenton rock and their exposure in the various quarries and outcrops of the region are shown upon the chart; the names of the quarries are given as they are familiarly known by us at Beloit. Between the St. Peters sandstone and the Trenton limestone are eight feet or perhaps more of transitional layers; they include at the bottom a foot or so of sandstone, more coarse and impure than is usual with the St. Peters, above this five feet of impure limestone and shale, and at the top two feet more of coarse sandstone. Above these transitional layers we have twenty-two feet of Lower Buff limestone, separated by well marked shaly seams at least, if not by lithological characters, into three or four subdivisions, everywhere recognizable

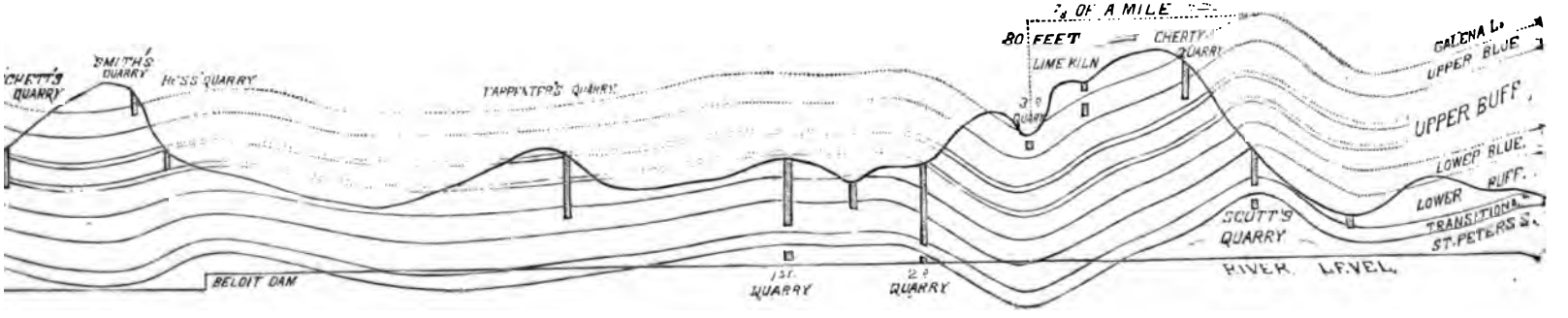

GALENA L.
FEET
UPPER BLUE
30
CHERTY
19
UPPER BUFF
UPPER FUCOIDAL
3
BIRDSEYE
7
LOWER FUCOIDAL
3½
CARPENTER
18½
TRENTON L.
LOWER BLUE
18
22
LOWER BUFF
TRANSITIONAL
8
ST. PETER'S S.
SMITH'S QUARRY
3D QUARRY
LIME KILN
CHERTY QUARRY
HANCHETT'S QUARRY
HESS QUARRY
ROCKTON
CARPENTER'S QUARRY
1ST. QUARRY
2D QUARRY
SCOTT'S QUARRY
JANESVILLE
CHART SHOWING THE STRATIGRAPHICAL RELATION OF THE OUTCROPS AT BELOIT, WIS.
By G. D. Swezey.

in the region as well as at Janesville. Above these are eighteen feet of Lower Blue limestone with two layers of a few inches each in thickness, one highly crystalline, the other very fossiliferous, easily recognizable in the three quarries which include this horizon. The Upper Buff limestone has been divided by Prof. Chamberlin into five subdivisions, known by us at Beloit as the Carpenter, Lower Fucoidal, Pseudo-birdseye, Upper Fucoidal and Cherty beds respectively; the lower and upper of these are still further divisible, as shown on the chart, and their divisions recognizable throughout the region and questionably as far away as Janesville. The Upper Blue limestone which completes the Trenton section is estimated at twenty feet in thickness, although as we shall see, this cannot be certainly determined.

Beginning with Scott's quarry, we have the transitional layers or nearly all of them, and just below, separated by a few feet unexposed, the characteristic St. Peters sandstone; in the Second railroad quarry, a mile and a quarter to the south, we have a portion of these layers exposed, and above them the entire thickness of Lower Buff and Lower Blue, and, in the broken and nearly inaccessible upper layers, probably the lower part of the Upper Buff layers; in two other quarries less than a mile from this, we find the same horizon, including the crystalline and fossiliferous layers before mentioned. In a ravine below Carpenter's quarry also, the Lower Blue layers are exposed. Carpenter's quarry forms the next step in the ladder, and here the exact matching becomes difficult owing to the broken and weathered condition of the top of the second quarry, and so we are obliged to call in the aid of the large quarry west of Janesville, which includes both of these horizons. There is in the very bottom of Carpenter's quarry a well marked shaly seam: a similar seam is found near the top of the second quarry, eighteen feet above the junction of lower buff and lower blue. At Janesville a seam is found seventeen feet above this junction, and at about this horizon the shaly fossiliferous Lower Blue layers pass by insensible gradations into the compact, unfossiliferous Carpenter beds. The fact that nearly all the subdivisions are a little thicker at Beloit than at Janesville, makes the difference of a foot in the height of this seam above the junc-

tion, just what we should expect; and so it is believed that this well marked seam is the same at Janesville, at the Second quarry and at Carpenter's, and it is made the point of division between the Lower Blue and Upper Buff beds. The upper part of Carpenter's quarry shows the Lower Fucoidal layers with their characteristic conchoidal fracture and brown markings, the Birdseye and in the very top the Upper Fucoidal. At Hess' quarry, a mile and three-quarters farther south, and at Hanchett's, another mile beyond, as well as at Rockton, four miles farther, these same layers are shown. Our next step in the ascending scale is made by the Cherty quarry, four miles to the north, and here our ladder breaks again and we must cross the state line and steal a few facts from our Sucker neighbors to splice it with. We learn from the Rockton quarry that the Cherty beds lie immediately above the three feet of Upper Fucoidal layers, and, although the lower part of the chert-bearing beds at Rockton are of a decidedly brecciated structure, while at the Cherty quarry they are not yet, we must conclude that they are the same, only laid down where the waves broke more violently, as might not be unlikely eight miles away. Moreover, the very top of Hess' quarry, although badly weathered, seems to be in this same horizon, and probably just about matches with the bottom of the Cherty quarry. In the upper half of this quarry and the two adjacent outcrops, we have the Upper Blue beds, while in one of them a higher exposure, separated by thirteen feet unexposed, shows the Galena beds with their characteristic *receptaculites*. The exact matching of these three quarries is a hopeless task; but among the numerous shaly seams there are two in each quarry that are well marked and about the same distance apart, which are believed to be identical. If this is so, the thickness of the Upper Blue layers is at least sixteen feet, and above this there is seven and a half feet between the top of the third quarry and the bottom of the upper exposure at the lime-kiln. Between these limits of sixteen and twenty-three and a half feet we may exercise our Yankee faculty of guessing; our guess is twenty feet. At Smith's quarry we find this junction of the Upper Blue with the Galena limestone which falls somewhat between the limits above mentioned. Our estimate gives the

DIAGRAM SHOWING
UNDULATIONS IN THE ROCK STRATA AT BELOIT, WIS.



total thickness of the Trenton limestone at one hundred and eleven feet.

It will thus be seen that the matching of our Beloit quarries is an interesting problem, somewhat complicated, but not too difficult; a class of college students, with a little oversight and direction from the teacher, are able to work it out with interest and satisfaction. We have just about outcrops enough, and very few superfluous; seven of our Beloit exposures are needed to complete the ascending scale.

Having now matched our exposures and determined the thickness of the various subdivisions, we have only to determine the altitude of each in order to learn whether there is any dip or undulation in the strata as traced from quarry to quarry; or whether they are, as shown on the chart, entirely level. The exposures lie mainly on a north and south line in the face of the west bluff of Rock river; moreover, the river, being set back at this point by the dam, affords a level base line; the altitude of the exposures above the river has been repeatedly taken by the aneroid barometer, and the average of these results is believed to be correct within a very few feet. The undulations which are thus detected are shown in the diagram, although of course greatly exaggerated. It will be seen that the four quarries farthest north show a considerable and quite regular dip to the south, amounting to eighty feet in seven-eighths of a mile; from here the strata rise again to the second quarry, beyond which they continue with but a slight and nearly uniform dip to the south. North of Scott's quarry there are two places where the junction of sandstone and limestone is shown in the road, from which we learn that the dip is sharp to the north. In the upper diagram the strata are traced still farther south, and also north through Janesville to Fulton; and although we know nothing as to minor undulations, we see that in general the strata are almost exactly level except where they drop down so abruptly at Beloit, constituting a little anticlinal elevation and a deeper synclinal depression of eighty feet; indeed, from Fulton to Rockton, a distance of thirty miles, the fall is only ninety-four feet; while at Beloit, as we have seen, the fall is almost as great in less than a mile. Although we know

nothing about minor undulations between Afton and Fulton, the exposures about Beloit are so numerous that no considerable undulations could exist undetected.

The exposures represented in the diagram do not all lie in a direct line by any means, but those which are of most interest as indicating these marked undulations do lie almost exactly in a north and south line. Hess' and Smith's quarries lie considerably to the west of this line, but another small exposure to the east of them, and more nearly in line, indicates almost exactly the same slight dip as they.

These outcrops all lie in the eastern face of the line of bluffs which forms the western boundary of the present Rock river bottoms. As we have seen, the Galena limestone is only found capping the highest hills. In the corresponding line of eastern bluffs, whose height is about the same, the Galena limestone is everywhere found, and the Trenton occurs only in the bottom of a deep ravine at Turtleville. This shows that the dip is prevailing eastward, which is to be presumed, since Beloit lies in the eastern slope of the north and south geanticlinal axis, which made Wisconsin the oldest state of the American continent, if not the oldest in the Union. The crest of this great geanticlinal runs down to the west of Beloit, giving our strata a slight slip to the east, amounting to about twenty-five feet in the five miles between the limekiln and the ravine at Turtleville. The undulations already traced are, therefore, of the nature of small anticlinal ridges and synclinal valleys crossing the main geanticlinal axis of Wisconsin. They are, of course, very small compared with it, but much more abrupt. The existence of similar, but much more extensive, humps on the camel's back is indicated by the fact that in two localities further south, in Illinois, the St. Peters sandstone comes to the surface; at Beloit it drops about to the river level; at Rockton the river runs over Trenton limestone; at the rapids south of Roscoe I have not seen the exposure, but from the rock and fossils I judge that it cuts through either the Lower Blue or, more likely, the Birdseye beds. But in Ogle county, Illinois, although the river is not at all abrupt to this point, the sandstone is found far above the river. A similar area is mapped by Worthen further south, in Illinois.

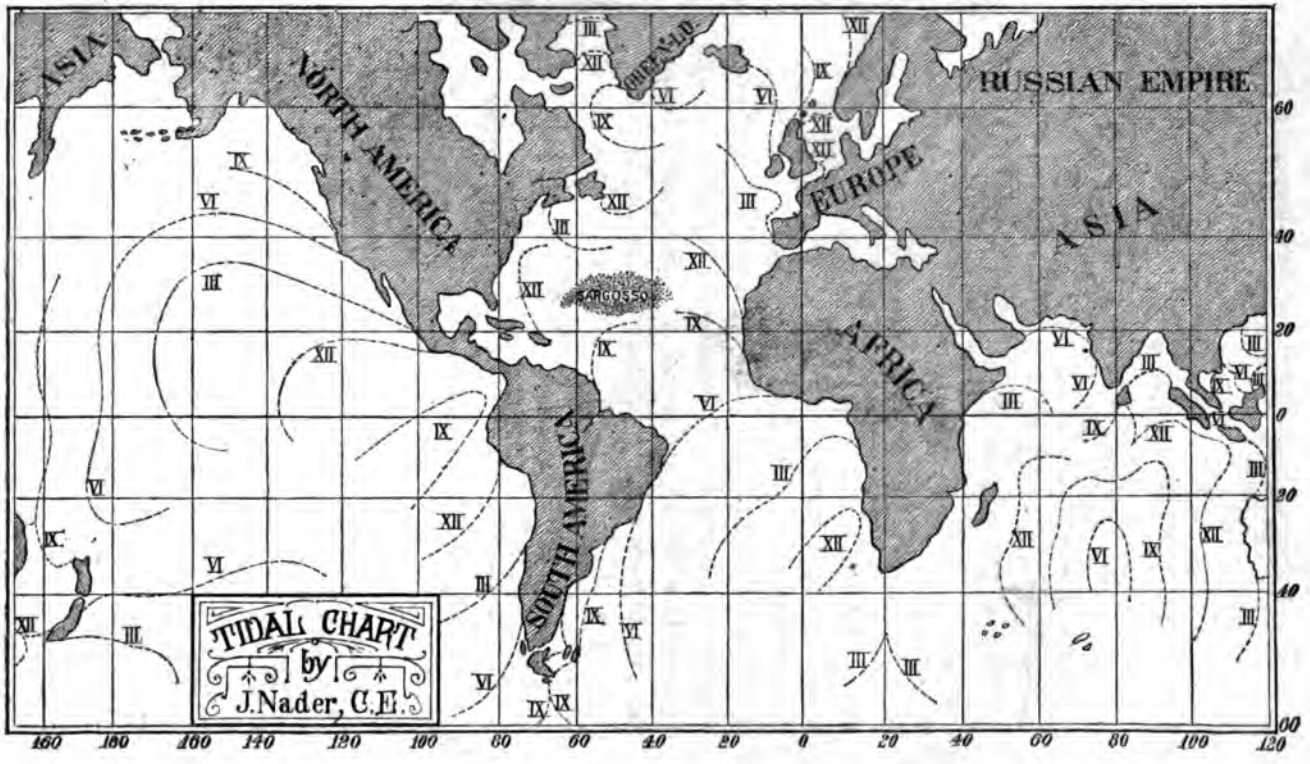
Without dwelling longer upon the stratigraphical relations of our rocks we pass on to note one or two points of interest in their later geological history.

The two lines of bluffs already mentioned which are the boundaries of the present Rock river bottoms, with their stratified Champlain gravels, were not only the banks of the Champlain lake into which the river expanded as a flood from the melting glacier, but they were also the banks of a rather remarkable channel which the preglacial Rock river cut for itself to the depth of over four hundred feet through Trenton limestone, St. Peters' sandstone, Lower Magnesian limestone and into the Potsdam sandstone; at least this was the depth as shown by the artesian well at Janesville, and at a point a few miles lower in its course it could not have been much less. That it is a preglacial valley is evident enough from the fact that the path of the glacier, as shown by striæ at Hanchett's quarry, was almost exactly west or squarely across the Rock river channel. This fact is in itself interesting as being the only case, so far as I know, in which glacial striæ are found outside the Kettle morain to indicate the direction in which the glacier had moved previous to the retreat and subsequent advance which formed the Kettle morain. The direction of the glacier in our region had been conjectured from some meagre data to be about southwest; the discovery of these markings is therefore of interest as showing that the tongue of ice which produced them, apparently a continuation of the Lake Michigan glacier, was, at this point at least, deflected perhaps by a valley to the north of the quarry, so as to move due west; this being the case, the banks of our preglacial valley were doubtless originally higher even than now, so that this ancient channel must have had rather a remarkable depth. Its width at Beloit is three to four miles; a few miles farther south it narrows to one and a half miles. At Rockton the confluence of the Pecatonica with Rock river constituted quite a lake in the Champlain period, but it does not represent so large a preglacial valley since the bottoms between Beloit and Rockton are underlaid by rock as shown in several places, showing that the Champlain floods escaped over the low rim of rock at that point and determined their own limits

in the unstratified Champlain deposits farther back. But to the east of Beloit the wells even do not strike rock, so far as I know, and so our deep preglacial valley must have had a width of three to four miles at Beloit, and farther north still greater. This is explicable from the fact that the soft St. Peters sandstone would be easily and extensively undermined by the river, so that the greatest depth of the channel may probably be only along a narrow channel in the middle into which the river cut its way and in which it lay until it was lifted out by the accumulating deposits from the melting glacier, widening as it was lifted higher and higher until it covered the present extensive bottoms.

The successive levels through which the river sank from this point are three in number, everywhere observable, besides some other terraces intermediate and not so well marked. The present river lies as a narrow stream, in general closely skirting the western bluffs and in places running upon the rock itself. The cause of this is detected by careful measurements with the aneroid barometer, which shows that the general level of the bottoms is somewhat higher on the eastern side than on the western, from which we infer that the rise of land to the north which set the river to cutting its terraces, was also, to some extent, a rise to the east of us, tipping the river over against its western bluff.

These rambling notes are presented not so much in the hope of enlightening as of interesting you in some of the geological questions which have interested us at Beloit.


TIDAL CHART
by
J. Nader, C.E.
ASIA
NORTH AMERICA
GREENLAND
RUSSIAN EMPIRE
EUROPE
ASIA
SARGOSSO
AFRICA
SOUTH AMERICA
160 180 160 140 120 100 80 60 40 20 0 20 40 60 80 100 120
60 40 20 0 20 40 60

THE TIDES.

By John Nader, Civil Engineer.

The ocean tide, this mysterious breathing of the sea, has attracted the attention of man from the earliest ages, and the cause was often assigned to some mysterious, if not supernatural agency. Pliny, in the first century, must have been studying the phenomena before he exclaimed, "Causa in Sole Lunâque;" as we proceed in this investimation we will see how nearly correct Pliny was in his remark. Since the announcement of the Copernican[1] system of the universe, many theories have been advanced, all purporting to account for the tides. Some of these were very ingenious and plausible, while others, as we will subsequently see, bordered on the absurd. "Descartes,"[2] as Guillemin says, "first dared to draw the veil and sound the mystery, and if he failed, it was only because of his preconceived ideas of the solar system."

As we shall endeavor to deduce the cause from the effect, we will first investigate the various phases and features of the phenomenon as they actually occur, and then endeavor to assign the cause. Considerable observation and study are required to obtain a clear understanding of the varied features of the tide, of the disturbing influences arising from various sources, and of the form of the true and distorted waves.

The first feature observed, is the periodic rising and falling of the surface of the ocean and the movement of the consequent currents.

The tidal wave in its simplest form is a long undulation of the surface of the ocean, the length of which is the distance between two consecutive high or low waters; the vertical range is very small when compared with the length, but increases as the length diminishes; the time, however, is and remains the same excepting in special cases.

---

[1] Nicolaus Copernicus. Born Feb. 9, 1473, Prussia. Died May 24, 1543. System de Mundi, 1507–1530–1543.

[2] Descartes. Born, 1596; died, 1650; 54 years.

The attending currents are the motion of the water on the slopes of the waves in obedience to gravitation. The excursions of these currents, at any particular point, are of short duration; the motion of the wave is so rapid compared with the current that a point in moving down one side is elevated by the advancing wave and left on the reverse slope to return and repeat the journey. It is not uncommon during still weather, to observe objects floating to and fro with the currents during several successive tides.

The figure of a normal or undistorted wave is nearly equal to a curve of sines of a circle whose diameter extends from high to low water with the center at mean level; if the semicircle and the half wave are divided into an equal number of parts, the sines and distances are the co-ordinates of the curve. As a rule the advance slope of the wave is the steeper of the two, for the axis is always inclined forward, owing to the resistance of friction. By comparing a diagram of an observed tide with the theoretical one, the distortion, if there is any, is at once recognized.

In the deep water of the ocean the volume necessary to form the wave in proportion to the force meets with little resistance, whereas in shallow water the resistance of friction from the bottom becomes considerable, and the wave which is thereby retarded in its progress is modified and the horizontal force is transformed into a vertical one; the water in front of the wave is drawn down to form the wave, thereby making the previous low water lower while the momentum of the wave heaps the water upon the obstructed portion, making the high water higher; and while the range is thus increased the length is proportionally diminished.

The tide is often much distorted by storms, so much in fact at times, as to almost lose its identity. A remarkable case occurred in New York Bay in the summer of 1869; it indicated that a vere storm was raging somewhere on the Atlantic ocean which arrested for a time the progress of a portion of the wave; the entire volume arrived in due time, but in a distorted form.

The force of the wind has also a great effect upon the tides in bays and rivers where at times every feature is disturbed beyond recognition. In the Delaware river in the winter of 1851 and

1852 the tide at Fort Delaware fell continuously for 36 hours in consequence of the wind blowing down stream, and instead of six feet the fall was actually fourteen.

The tides have their origin in the oceans and thence proceed to our shores, part of the time as forced and part of the time as free waves, that is to say, they are moving part of the time under the action of the tide-making force and when by the earth's rotation they are removed from this influence they continue under their own *vis-viva* until again brought within the influence of the same cause. After investigating some of the peculiarities of the tides on the coasts, we will return to the ocean wave. After reaching the coast the tide enters every bay and river within its scope, and, while doing so, undergoes many modifications. The range is subject to change with every change in the cross-section, so that observations along a river will vary considerable even at short distances. In extensive bays the fact is more marked than in rivers, the range, which is increased by the contraction of the inlet, is at once diminished when the wave enters and spreads in the basin, but, while the influx is retarded, the main wave passes by, the ocean falls and efflux begins before the bay is filled to the ocean level, so that the bay never rises to a level with the ocean and for the same reason also, never becomes as low. The Delaware and Chesapeake bays are cases of this kind; the Mexican gulf is one of the most extreme and will receive special notice further on.

The time card of steamers carrying on small tidal rivers is a curiosity to those not familiar with such rivers, some of which have scarce one foot of water at their entrance at low tide, so that the boats are obliged to enter and leave the river on the tide wave and their time must vary from day to day as we find the tides do vary. On large tidal rivers the case is different. Vessels will meet several tides during one trip, as, for instance, on the Hudson river, New York. The tide which passes New York city at 8:13 A. M., reaches Albany at 3:30 P. M., with a mean velocity of about 17 miles an hour so that the length of the half wave, from high to low water, is about 100 miles.

A boat leaving Albany at high water, at say 15 miles an hour,

on the *ebb*, reaches low water in a little over three hours; then at the rate of twelve miles an hour on the *flood*, reaches high water in 3½ hours more 40 miles above New York, which point (New York) it makes in 2½ hours more and is then within 20 miles of the next low water. On the upstream trip the conditions would be different. Here it would only be a question of speed between the boat and the wave, and if the boat left at low water on the first of the *flood* current, it would meet the contrary current about 20 miles below Albany. The fact is that the trip upstream is made in less time than that downstream.

The tide of Long Island Sound and the East river, is remarkable in several respects. That portion of the tide which enters at Sandy Hook moves slowly up the narrow channel of the East river and a few miles above New York encounters another portion of the same ocean tide which entered the Sound at Montauk Point and flowed back through the Sound over 100 miles in the meantime.

With a reasonably fair idea of the tides, the most remarkable feature may appear to be their regularity, but by the time the novelty has worn off there may also arise some doubts upon that point in the mind of the observer.

If the observations should begin at a particular time, there will be two precisely similar waves, in something less than 25 hours. In the course of a few days, during which the tides will appear later each day, the two tides will become unequal in range, at the same time both may be higher or lower than when first observed, the evening tide may be the greater yet it is just as possible that the morning tide will be the greater of the two, depending entirely upon the time when the observations commenced.

Before progressing any further we will be obliged to assume some means of comparison to enable us to pursue the subject intelligently. Now, if we find that the phases of any two or more distinct phenomena run parallel, or in other words coincide, we may conclude that one is either the cause or companion of the other.

The phases of the tide compare in point of time exactly with those of the moon so that the moon is either the cause of the tides or their companion subject to the same laws.

The two equal tides take place when the moon has no declination, i. e., when in the plane of the earth's equator no matter what its position otherwise may chance to be. When the moon moves north or south of the equator the tides become unequal. In most localities the highest of the two will be the one following the upper transit during north declinations and lower transits during south declinations; when the tides observed do not succeed the transit which attends their formation, the exact reverse of this is true. Leaving aside the semi-diurnal inequalities, the highest tides occur at new and full moon and are known as *spring tides*, the least tides occur when the moon is in her quadratures and are known as *neap tides*. The highest of the high tides occur when the full or change takes place during maximum declinations, then one of the waves is much larger than the other, in some localities the inequality is so great as to compound the two waves to such a degree that only one distorted wave is apparent in 24 hours.

The mean time from the moon's upper transit to the succeeding high water, during a lunation, is called the "Corrected Establishment" or the "Establishment of the Port." The establishment is used by mariners and others for calculating the time of the tide from the position of the moon.

In the Gulf of Mexico the tides are more complicated; in Galveston Bay two very small irregular tides are observable in 24 hours when the declination of the moon is small, when this increases either way, the two become unequal until only one high water is recognizable in 24 hours; this continues several days before and after maximum declination.

By careful obseavations the two compounded waves are observable unless affected by local disturbances which latter often exceed the range of the tide which is from one-half to two feet.

The foregoing facts illustrate the general features of the tides and warrant the assumption that the moon is in some manner connected with the same.

If we examine the coast lines of continents we will observe a general similarity in some while in others we may even compare their details and in either case find remarkable resemblance which

has suggested the idea, to some of our geographers, of joining the continents and assuming lines of cleavage.

South America, Africa and Oceanica have a strong resemblance; the locations of such detached portions as the Falkland Islands, Madagascar, New Zealand, Ceylon and Formosa are notable; the Fjords of Norway and Patagonia and the Firths of Scotland resemble each other closely, while the serrated S. W. coast of Ireland is the duplicate of the to coast of Maine. In these localities the tide impinges upon the coast in the same manner, in each case, both as to direction and impulse.

We may further observe the work of erosion of the average tide and of the greater at maximum declinations in the double indented coasts on the west of the continents, the first impulse of the tide being from west to east in nearly all cases.

According to the usually accepted theory of the tides, the moon elevates the water of the ocean by attraction. Now, if we admit of attraction, we must also admit of its laws according to one of which, bodies attract with a force in direct proportion to their masses. The mass of the sun is such that his attraction upon the earth is 170 times greater than the moon's and the tide should be in proportion to the respective attractive powers of the two bodies.

Reclus in "The Ocean" says that, "the solar tides would be 5000-6000 feet high if the true cause of the tides was not to be found in the difference of attraction exercised on the waters of the different parts of the earth." The difference of the moon's attraction on the near and remote sides of the earth is just twice the difference of the sun's, while the sun's attraction is 589 millionths of the earth's gravity and moon's attraction is only 34½ millionths. The centrifugal force at the equator due to the earth's rotation is the 1-289th part of the earth's gravity and hence only six times greater than the sun's attraction, while it is more than 1000 times greater than the moon's.

The moon's assumed affinity for aqueous matter we will not consider since we have as yet no reason to doubt that gravitation is the same throughout the Universe. In space, all matter is attracted alike, that some bodies are heavier than others is that they,

on account of their density, contain a greater mass, and gravity acting upon this mass gives them their preponderance, at the same time one volume will respond to the force of gravity as readily as another, nothwithstanding their different densities.

A tide occurs at opposste sides of the earth at the same time, that is, one tide follows the upper transit of the moon and another the lower one in the same place. The water is said to be drawn away from the earth on one side and the earth away from the water on the remote side.

We know that two forces acting in the same direction are represented by a simple sum of these forces and that attraction acting from one side through a body upon matter on the opposite side will only aid gravity in holding that matter more securely on that side, but, it is admitted that matter is heavier on the earth's surface on the side remote from the sun, which fact recalls the argument, that if anything is affected by foreign attraction it will be affected most by the superior force.

Argumeet aside, the tide is certainly obedient to the moon, but the manner in which this is brought about, is the problem to be solved.

One feature of the phenomena which is used to show that the tide is raised by attraction, is the difference in range of the semi-diurnal tides at different positions of the moon, the higher tide succeeding the superior transit and north declination and the lower transit during south declination, showing that the moon draws the water after it.

Now let us see how true this is.

The Atlantic tide is created in the southern part of the South Atlantic ocean, and moving eastward reaches the African coast shortly after the moon's transit at that place. Thence it moves north and west, reaching the United States coast twelve hours later. The other side of the wave in connection with the Arctic tide moving east and north, reaches Ireland four hours later, and Dover straits twelve hours later still; so that in some places it is the tide after moon's transit, and in others the previous tide which is observed, so that the facts become reversed.

Nearly all authors on this subject — the tides — are satisfied

with nothing less than the great South Pacific ocean, a thousand miles off shore, for sufficient space to create the tidal wave, whence they propagate the same all over the world from east to west. Some think it possible that there is a new impulse given in each ocean, while others think that possibly the origin may be in the Indian ocean.

That these speculations are not all correct is evident from my chart of co-tidal lines, which is based upon a collection of actual facts from undoubted sources. One tide reaches the west coast of Africa at the same moment of absolute time that another reaches the east coast of Madagascar. These can by no means be the same wave in any form, for, after reaching the respective coasts, a portion of each moves southward, these meet near the Cape of Good Hope, unite, and move south as one wave. One tide arrives on the west shore of Patagonia at the same time that another reaches the east shore of the Falkland Islands. These move south and three hours later unite near Cape Horn and go south as one wave. These also are two entirely separate and distinct tides coming from different oceans and from opposite directions. A still more remarkable tide is that which reaches the north end of New Zealand from the northeast. This tide travels south between Austria and New Zealand, is met by a tide from the Indian ocean south of Tasmania, is turned eastward and makes the detour of New Zealand in time to pass the succeeding tide off the north end of the Islands. This wave is an important one, as it returns just in time to reform the Pacific tide. The Society Islands, where there is no perceptible tide, lie in the node between the ascending and descending tides. The solar tide of 5–6 inches reported at Tahiti is occasioned by the shifting of the node of no tide, and the time, three hours before and after noon and midnight, is occasioned by what is termed *priming* and *lagging* of the lunar tides.

The tide of the Indian ocean has its origin near the center of that ocean, first moving decidedly north and east and then spreading in a north and west direction. Owing to the great difference in depth of this ocean and the consequent resistance, this tide is subject to movements peculiar to itself. The Maldive islands are

situate 400 miles west of Ceylon, and occupy 500 miles in a north and south direction by about 40 miles wide. They are divided into numerous groups by navigable channels of various depths. It is estimated that the whole number of islands or Atols is no less than 50,000, of which the largest is not more than eight miles in circumference. These islands present an immense barrier to the tide, so that one portion is retarded, while another portion moves on rapidly, making a large detour returns upon the retarded portion like an eddy. The wave moving westward with a great convex front reaches Madagascar, and, passing around both ends, fills Mozambique Channel with high water in half an hour. One portion then passes southwest and meets the south Atlantic tide, the other advances north to Cape Gardafui, then moves eastward with great velocity to the west coast of Hindoostan, filling the Arabian sea, and moving south reaches the Maldives eight hours after the main wave has passed the same point and entered the Bay of Bengal. It will also be observed that the easterly side of this tide moves both north and south of Australia; that on the north meets the Pacific tide coming through Torres straits with a difference of four hours; that on the south travels beyond Tasmania and joins a portion of the Pacific tide, a portion of both, however, returning from South Victoria along the Antarctic continent to maintain the equilibrium.

The tide in the north Atlantic, which had its origin partly in the Arctic Ocean and partly in the south Atlantic, moves eastward with an extensive convex front and divides on the south end of the British Isles; one portion enters the British Channel and reaches Dover Straits in the time that the other portion makes the entrance to the North Sea. The tide in Dover Straits meets another which entered the North Sea twelve hours before but passes to the east of it and along the coast of France and the Netherlands, and combining with a later tide from the north reaches the Skaw 17 hours after passing Callais, while another portion of this identical tide travels south along the English coast. It will be observed that there is always a whole wave in the North Sea which is necessary to preserve the sequence.

The tide passing north to Martha's Vineyard is met at Nan-

tucket by a tide from the north four hours younger, but of greater range, so that it is superposed on the lesser. The origin of the Arctic tide is not traceable for want of data in these waters, but it ascends Baffin's Bay.

These facts go to show that we have not one but a number of primary tides, created in different ocaans, acting in perfect harmony and repeating their phases as regular as the moon.

Observing the different motion of the tides, we find that they obey in a particular manner certain varying impulses. Primarily they move east, then west, with a general tendency to and from the equator, unless interrupted by obstructions; and on the whole they partake of a circular motion in time to repeat.

The original motion is a most decisive one, not as though a stone were thrown into the water, as the comparison is sometimes made, but just the opposite; the greater portion of a whole ocean appears to heave and rise into a wave in the course of a few hours.

In particular cases the impulse and its direction are very marked owing to local interferences, such as the Bay of Fundy, where the tide reaches the coast with great rapidity through a tongue of very deep water, then moves endwise to the east, meets with the obstruction of Nova Scotia, so that the wave is augmented to alarming dimensions. Bristol Channel and a number of other places are subject to similar tides, but of less extent. On the other hand we find some cases of this kind in the other direction, for instance the entrance to Magellan Straits, where the tide attains a range of 40 feet and over.

The foregoing are facts obtained from long observation and careful investigation of the phenomena. More than 4,000 reliable data were collected from tables such as "Bowditch's Navigator," Imray & Son's "Lights and Tides of the World," and various other equally reliable sources. These were all reduced to absolute time (Greenwich time) and platted on charts in their respective places. The true places of the co-tidal lines were thus obtained, and the result shows beyond a doubt that the charts of co-tidal lines now in use are far from being correct.

In Pliny's judgment the cause was the sun and moon. We

will also examine the remarks of others on this subject and see how they agree.

The New Am. Cyc. says: "The close relation which the times of high water bear to the times of the moon's passage shows that the moon's influence in raising the tides must be greater than the sun's. In fact, while the whole attraction of the sun upon the earth far exceeds that of the moon, yet, owing to the greater proximity of the latter, the difference between its attraction at the center of the earth and at the nearest and most remote points of its surface, which produces the tides, is about two and one-half times as great as the sun's attraction at the same points."

The argument might answer if the moon was very near the earth so as to gather the water by tangental motion into a wave beneath it until resisted by gravitation, provided also, that sufficient time was allowed, as we are not dealing with a uniform envelop of water, but with oceans separated by continents, and although the velocity of the tides is great, the translation of the water is very slow, not such as would be required in heaping up the water as the moon overleaps the continents from ocean to ocean, whereas the wave comes up as though impelled by a sudden blow or stroke. An article on tides by repulsion in Vol. 4 of the South. Litt. Mess. says: "When La Place[1] had ascertained the fact, that as the mooon passed over the Atlantic it was low water under her and the swell was on either side of her, north and south, and the further from the moon the greater the swell, is it not a little strange that he should have come to the conclusion that the moon was drawing up the water towards herself," further from the same; "as whenever the moon is vertical to any place, it is invariably low water." These remarks, when properly applied, are correct so far as the position of the wave is concerned. Bowditch in Mech. Celeste says: "By a remarkable singularity, the low water takes place when the two bodies are in the meridian, and the high water when they are in the horizon; so that the tide subsides at the equator, under the body that attracts it." It appears that the origin of the tide is lost sight of, and the time

[1] La Place. Born, 1748; died, 1827.

required to reach the position of the moon is not considered, there are times, however, when the tide is under the moon, but, if we find the moon over a low water, we will also find the parent wave in deep water on on the same meridian.

The same author, in the Messenger, further says: "And as when the moon approaches the meridian of Babelmandeb the the water will fall there but continues its elevation on each side as at Tonquin and in the Mozambique channel," also, "the tide remaining up so long at Tonquin gave rise to the notion, very strangely indeed, that two tides met at that place."

It is merely necessary to examine the facts in both these cases and we will find that the falling water at Babelmandeb is the tide of the moon's previous transit, while tide in the Mozambique channel is that of the immediate transit which culminates with the moon in the Indian ocean in longitude 80° E, but does not culminate in the Mozambique until the moon has reached longitude 20° W. The tide at Tonquin is a part of the Pacific tide which enters the China sea through the Bashee and Balintang channels between Formosa and Luzon and also a small tide from the Balabec straits, these unite before reaching the Gulf of Tonquin, leaving a regular tide of 4 to six feet. There is, however, a tide from the Indian ocean through Mallacca and Sunda Straits which causes interferance in the Gulf of Siam, a body of water similar to the Gulf of Tonquin but ten degrees of latitude nearer the equator; the spring tides are only two feet at the entrance but increase at the head of the gulf, so that the tide at Cape Liant is seven feet, the time, however, is disturbed, so that the tide rises three hours and falls nine.

The irregularities of the tide in the Straits of Magellan are drawn upon to favor the theory by repulsion. These tides are such as would serve any desirable purpose. When the moon is over the Atlantic the tide of the previous transit begins to rise at Cape Virgins, so also the tide at Cape Pillar on the Pacific side and in Cockburn Channel.

During three hours when the moon is over the Atlantic the tide at Cape Pillar does three honrs of its rising phase, at Cockburn Channel the last two of falling and the first of rising and at Cape

Virgins the last of rising and first two hours of falling of the previous tide. Now when the moon is over the Pacific, say at 8 hours absolute time longitude 120° W., then it is two hours after high water at Cape Pillar, just high water at Cockburn Channel and seven hours after high water at Cape Virgins or five hours before the high water succeeding the present moon. These conflicting phases make the problem a very complicated one and the more so when we consider the difference in range of these irregular tides. The tide at Cape Pillar at the sixth hour rises scarce five feet; in the Cockburn Channel at the eight hour about five (this tide divides into two branches on Clarence Island), while the tide at Cape Virgins at the thirteenth hour has a range of from 38 to 42 feet. Reclus says that Fitzroy has measured tides here as high as 62 feet. When we further consider the variable width of the Straits with two narrows one of which is described as being like the passage of the Bosphorus from the Black Sea into the Marmara Sea we may conclude the hopeless task of attributing these irregular fluctuation to any supposed cause whatever.

An article in Vol. 34 of the *American Journal of Science* says: "That the attraction of the moon regulates the times of the tides caused by the gulf stream, is evident." Further: "Why does the ocean always run swiftly into the Mediterranean Sea? No doubt to keep up the subterranean stream which passes out of the Bay of Mexico, called the Gulf stream."

Here, in the first place is a confounding of cause and effect, the motion of the tidal wave gives a slow progressive motion to a large volume of water.

The waters of the Atlantic set in motion by the tide reflect from the African shore and move in a north west direction; after passing Cape St. Rogue the waters tarry six months under a tropical sun before discharging from the Straits of Florida a volume of water equal to 3,000 Mississippi rivers.

The constant current into the Mediterranean, which until recently was considered to be the consequence of the evaporation of the Sea, is only a surface current, and quite recently a strong counter-current has been discovered at the bottom of Gibraltar Straits setting into the Atlantic and accounting for the greater

part of the influx at the surface. This strait is large enough to give freedom to tides and currents, its length from Cape Trafalgar to Europa point, in Sprin, is 36 miles and its width from 15 to 24 miles, its depth is as much as 5,000 feet. The spring tides at Lissa Island in the Adriatic are 2½ feet and at Tripoli, Syria, at the extreme east end of the Mediterranean, they have still a range of two feet.

The New American Cycopedia speaking of the age of the tide, says: "This delay, which even at the Cape of Good Hope amounts to fourteen hours, is still the subject of investigation and is probably mainly due to friction."

If the co-tidal charts by Whewell and others were correct, then the delay would be much greater than that here mentioned, these charts give the origin of the tide in the Pactfic, thence they bring the tide across the Pacific and Indian ocean and into the Atlantic by way of the Cape of Good Hope. The fact is, that this tide is created in the Atlantic ocean exactly on time with moon's transit, so that there is no delay at this point, but from here the tide is twelve hours in reaching the United States coast, 14 in reaching Spain and 24 hours readhing Dover by way of the British Channel.

From the same source we have the following:

"If the tides arrive at the same place by two different channels and one of them is retarded behind the other by six hours, in consequence of traveling a longer route or in shallow water, the semidiurnal tides will be destroyed by an interference of the waves, that is, by the high water of one being superimposed on the low water of the other."

This phenomenon is common, two waves unite and one is the result, but, this does not prevent a recurrence after 12 lunar hours, the semidiurnal phase is not affected whatever in any case. If the tide divides on, and passes around an island, the two parts unite and reform the wave, or, if the tides meet in a long channel the result is a commotion which stops both until drawn down by the succeeding tides, or they may, as at the Isle of Wight, cross each other both ways causing double high tides. In this case the tide from the west enters the "Solent" at ten hours with a range

of 7–8 feet, and, the main wave having reached Spithead, another tide enters here a little over one hour later with a range of 12 to 13 feet so that there is a second highwater 2¼ hours after the first at Southampton; the second tide passes also to the west from "Cowes," after the first has passed making a second highwater at Lymington. The two parts of the tide wave remain distinct. The point of meeting or crossing at Cowes is such as to leave the general direction of the tides at rightangles and it can be practically demonstrated that two sets of waves may travel in this manner without any serious interference.

When, however, two tides meet in the ocean, they will form one wave which will progress in a direction which will be the resultant of the previous direction and velocity of the separate tides. We must also bear in mind that in all, excepting rare cases, the tide in question supplants a wave which occupied the same location twelve hours before.

The semi-diurnal tides may differ to such an extent that the high water of one corresponds with the low water of the other, and may leave the impression of but one or a *diurnal* tide, the appellation however is a misnomer, there being really no diurnal tide; the distortion can be recognized in every case so that there is no question of there being two tides. This compounding is not due to a meeting of tides but to the location and time of the originating impulse as we will see further on.

It happens at times that one of the semi-diurnal tides is entirely lost and this is, when the wave is small and travels free by its own *vis viva* after the force is removed, being constantly retarded in its movement and at length unable any longer to overcome the resistance of friction the wave finally stops and is lost. This is the case in the gulf tides when the moon's declination is maximum, one of the waves is so small that it is scarcely distinguishable and is at times lost before reaching the coast.

Where two tides of the same type but of nifferent origin meet as at Cape Horn and the Cape of Good Hope, they unite and become one wave. The meeting of the tide off the capes will account for the turbulent condition of the sea in these localities.

Only a few of many tidal theories are noticed tn the foregoing

remarks and it appears that in every instance the authors had a very indifferent knowledge of tidal phenomena.

Reclus was not far from correct when he said: "Cotidals according Whewell are accepted, but it is not certain that things occur in this way, in fact, it is ascertained that in each oceanic basin the tide seems to start from the centre and be propagated in all directions parallel to the general direction of the coasts."

This remark was a welcome discovery when the accompanying chart began to develop into its present form, so also a statement from an unknown author, that the tide possibly had its origin in the middle of the Indian Ocean: also the report of a British naval commander who stated "that instead of a constant current westward around the Cape of Good Hope he had known vessels to remain stationary for days and even to drift to the east." Now it is safe to say that had the tide been constantly in one direction around the cape, as it was supposed to be, then the current would also have been constant in the same direction.

The tides of the British Channel and North Sea have already been mentioned but owing to so singular phenomena a special investigation will be interesting. The accompanying chart shows every feature of these remarkable tides.

The cotidal lines represent the progress at each hour of absolute time; the age of the tide is reckoned from its origin in the South Atlantic when the moon transits the meridian of Greenwich at 12 o'clock noon or midnight (this is at full and change).

A tongue of deep water, over 2,500 fathoms deep, extends far into the Bay of Biscay, and when the tide arrives off this point it makes a decided lateral move into the bay with great velocity, from the 14th to the 15th hour, at the same time approaching the shores of Ireland and England, dividing on Cape Clear at the 16th and Lands End a little before the 17th hour; the southeast portion passes through the British channel and Dover straits in a northeast direction at the 24th hour, and it here passes a tide on its west 12 hours older. Meeting as they do, these tides reflect and preserve their individuality on opposite shores in opposite directions. The tide from the channel keeps along the east shore and meets a tide off the coast of Jutland 12 hours younger than

the one we have followed thus far. But where is our associate? While we were lingering in the channel, and the straits, he went around the longer way with great strides and met our predecessor at the point where we now are, just as we were tasting of the Dutch Rhine, and combining with him made the passage of the Skagger Rack and washed the shores of Gotheborg Sweden at 30 hours as we shall when 42 hours old. From Cape Clear the tide moves along the west shore of Ireland, the Western Isles and coast of Scotland, reaching the Orkney and Shetland Isles at the 21st hour. Here it divides, never to meet again; one part passes between the Islands and moves south along the coast of Scotland and England and at the mouth of the Thames at the 36th hour passes a Channel tide 24 hours old, its own associate is already approaching Jutland. The tide between the Shetlands and Norway moves rapidly southeastward through a belt of water over 100 fathoms deep, and at the 26th hour meets a channel tide 12 hours older, as we have before observed. When this Norway tide departs eastward a portion breaks to the westward and follows the main wave along the coast of Scotland, but, being delayed by several hours, causes a second high water, thus making apparent four highwaters as far as Peter Head. These four tides were attributed to the channel tides, but it is evident that if this was the case, the tides would be observed along the English rather than the Scottish coast. The middle of the North Sea has no tide, which is corroborated by careful soundings made by the British navy over a shoal where no oscillation was observed. From this it will be observed that there can be not less than two tidal waves in the North Sea at any time, and as many as four at one time during each phase, the resulting confusion of currents can easier be imagined than described.

A portion of the tide which we have been considering enters St. George's and Bristol channels, also the North channel into the Irish sea. The waves by St. George's and North channels meet near the the Isle of Man about the 23d hour, their range along the Irish coast was moderate, but the meeting produces a range of 20 feet and over.

The tide in the Bristol channel, charging straight from the sea

into a nearly uniformly contracting channel, increases rapidly in range as it ascends the Severn. Entering with range of 20 feet it increases to 27 at Ilfracombe, to 35 at Bridgewater Bay, to 37 at Cardiff, 38 at Chepstow and to 40 feet at Bristol. Above Bristol the entire rise occurs in about two hours, and the fall in about ten. Here the resistance of friction is such that the axis of the wave is much inclined by the dragging of the front, and the impulse from the momentum of the volume. The front of the wave becomes steeper and the rear slope much longer, the latter being drawn to supply the next wave.

The *Mascarret Eager* or *Barre* is an exaggerated distortion due to excessive contraction either lateral or vertical. The immediate cause of this phenomenon is, that a sufficient quantity of water to preserve the form of the wave is unable to rise in front before it is overwhelmed by the heaped up water of the wave whose axis is inclined so far from the vertical that it breaks over and rolls along upon the surface. When occasioned by excessive lateral contraction, the *eager* forms at and follows along the shores of the stream, but when caused by shoals in the middle grounds it forms and follows up the middle of the stream, preserving its identity for a considerable time after passing the cause of the abnormity. A few short waves generally follow the *eager*, leaving high water immediately behind them.

While investigating the various phases of the tidal phenomena, it must be noticed that there always has been a determination to have the tide move with the moon from east to west, and owing to this desire many aspects have remained unnoticed, or have been disregarded because they happened to conflict with some theory under construction. In nearly all articles on tides the common remark is, that "in tidal rivers the tide always moves up-stream, even when this is in the opposite direction to that in which the moon appears to move." This would imply that tide should remain under the moon while the earth revolved to the east, and that the tides on the east shores are produced by the advance of the solid earth against the suspended mobile waters. It is true, the tide moves south along the east shores of Scotland and England, but, as we have seen, it is also true that at the same time

there is a tide on the west shore of the Netherlands in the same latitude. The course of the Severn, before noticed, is eastward from the sea, so also the direction of the Bay of Fundy, with 70 feet tide. These facts are sufficient to show that the tide does not follow the moon in her apparent course from east to west, while the earth is revolving on its axis from west to east.

For the purpose of attracting attention to coincidences, a few of the principal mountain chains are given on the chart of which the tides and the conformation of the coasts are, however, the principal features. It will be observed that after forming in the deepest part of the oceans, the first point of impact of the tides is against the foot of a chain of mountains. The indentations of the coasts are not wholly the effect of tidal abrasion, as is indicated by the parallel position of the mountains, but indicate that the tide producing force now operative was active in contributing towards the formation of continents in a fluid much denser than that which it now propels.

By observing the beginning and progress of a storm at sea, we may form some idea of how nature has grown into equilibrium. When the storm begins the waves are varied in form and size and their motions are tumultuous, but when at length sufficient matter is set in motion to satisfy the conditions between the force acting and the surface under action, then the waves become perfect in form and their regularity will bear comparison with the tides.

The tide producing force necessarily acts upon all bodies of water, either great or small, but its effect is very different in lakes and inland seas from what it is in the oceans. In the former there is a constant and ineffectual effort to produce regularity, in the latter the oscillation is established.

The mass and extent of surface must be proportioned to the force. In inland lakes and seas there are continued fluctuations, but small, and the intervals are short, the duration being from a few minutes to several hours.

These oscillations are the result of the tide producing force and the irregularity is the effect of interference and reaction, the surface, mass and force not being in correct proportion.

The lake and also ocean tides may be illustrated by a simple

experiment and the various phases and interferences may be produced just as they occur in nature.

If we take a basin of water and agitate the same, we may produce one or more waves; if now we regulate the impulse while we observe the motion, we may time the same so as to produce regular oscillations which will continue until a change of force takes place; whenever such change takes place either in amount or duration, interferences will appear which after a time will cause the wave or waves to come to a state of rest, but if the same impulse continues, the oscillations begin again, increase to maximum, diminish and again cease.

This will be the case whether the impulse be greater or less or the time faster or slower than that necessary to produce regularity. This is practically true of the great lakes, the oscillations observed are the effect of the tide producing force which is entirely disproportioned to the extent of the volume acted upon, the resulting irregularities recur in periods from which the tide may be determined by elimination.

There are many peculiarities attending the tides as they meet with the varied obstructions of the coast, prominent among these is that the range of tide is less at the most advanced portions of a continent than at either side. The advancing tide in these cases meets with the resistance of the submerged portion of the Cape long before reaching the coast and departs to either hand, thereby diminishing the tide at the cape, which, having reached the coast, divides, and by its momentum crowds upon that part of the tide already making in the bays or indentations of the coast on either side.

We have thus far followed the tidal phenomena through all their principal phases with the moon as the cause or companion of the same.

In order to deduce the cause of the tides we will refer to first principles and then compare facts with the laws of nature. According to Keppler's[1] two first laws, based upon the observations

---

[1] Johan Keppler, Wurtemburg. Born 1570, died 1630. 1st and 2d, 1609; 3rd, 1618, May 15.

of Tycho Brahé[1] and published in 1609, the planets revolve around the sun in elliptical orbits and their radii vectores describe equal areas in equal times. The moon is supposed to revolve about the earth in this manner, the orbit being elliptical with the earth occupying one of the foci. Now, Keppler's laws are strictly true when only one planet and the sun are considered, but in a system, they are subject to complicated pertutbations. Newton's[2] Principle, based upon Keppler's laws half a century later, is consequently subject to equally complicated modifications.

According to the laws of gravitation, all bodies attract each other in proportion to their mass and inversely as the squares of the distance, also, bodies which mutually attract each other revolve around their common centers of gravity. These apply to our whole system, and we may say, to the whole universe. Between the earth and moon there will be a point which will describe an orbit around the sun while the earth's center will describe a circle around this common center of revolution. There will appear some complication, for while the two bodies revolve about a common center, the moon is describing an elliptical orbit whose excentricity varies between 1·18 and 1·15 and whose major axis makes a complete revolution in about nine years in direct motion, and although both conditions cannot be entirely true at the same time, yet this will not alter the law while it modifies the results. When the moon is in quadratures both bodies are affected alike by the sun, as the common center lies in their mutual orbit. At this instant either law will apply as the respective orbits of the moon due to either law coincide at this point, and although it may be said that the earth has actual control, its force being at right angles to that of the sun at this point, the moon is actually performing a planetary orbit about the sun.

As soon however as the moon moves out of quadratures in the ellipse, the earth yields to the law of mutual attraction, on account of the dominant force of the sun, its center describes an undu-

---

[1] Tycho Brahé, a Dane. Born 1546, died 1601. Rejected Corernicus.

[2] Newton, born 1642, died 1727. Principia, 1627.

lating course about the sun and the common center or point of revolution between the earth and moon describes the orbit.

The ultimate result of these antagonistic efforts is, that the point of revolution between the earth and moon fluctuates between the earth's center and the common center of gravity of the two bodies.

The earth revolves about the common center of revolution, which lies within its own volume, with the same regular velocity that the moon revolves in her orbit. This motion produces a centrifugal force, which, owing to eccentricity, is tangent to the earth only in the plane of the moon and the axis of rotation; the constant change of the axis causes this force to fluctuate between nil and maximum twice in a lunation, that is, nil at quadratures and maximum at syzygies.

The force thus produced, which I will call centrifugal preponderance, varies between the 1·900 and 1·500 of the centrifugal force due to the earth's rotary motion. The effect of the earth's rotation was to produce the spheroidal form of the earth and its present office is to maintain it with a flattening at the poles of nearly 26 miles; if this force were to cease, the oceans would retire to the poles.

Now a force equal to 1·900 part of this, acting uniformly and constantly, would, if we simply consider the result proportionate to the force, cause a flattening of 150 feet, but as we shall see, this force does not act uniformly or constantly, neither have we a continuous mobile surface to consider acted upon, so that this change of form is impossible. Should we however assume a uniform surface of water and taking this force as acting in the mean one-half the time on one-tenth of the surface on opposite sides, we would have a tide of seven feet which agrees with the protuberances of the Elipsoid of water produced by some highly scientific investigations.

The eccentricity of the force causes the same to deviate from the centrifugal force due to the earth's rotation everywhere on the surface excepting at two points; these are, the point directly under the moon and the point opposite. At other points in the plane of the moon's orbit it has a tendency of only slightly de-

flecting the earth's force, and in the endeavor to overcome the superior force of gravity the waters are thereby depressed shortly before being presented to the point of activity and hence are prepared to leap forward to meet the moon at its transit as the tides are known to do.

The centrifugal force is greatest in the plane of the moon's orbit and diminishes towards the poles of rotation in proportion to the cosine of the angular distance so that at the distance of 60 degrees it is reduced to one half. The centrifugal force of a rotating sphere is everywhere parallel to the plane of the equator; the components of this force at any point are: a force acting in opposition to gravity and a force at right angles to the same, having a tendency to move matter towards the equator. This is the case with the tides, for no sooner have they formed, in fact during their formation, they depart toward the equator.

To follow the recurring impulse upon the tides as they depart from their origin on their respective journeys must here be omitted for want of time, by comparing the cotidal lines on the chart with the moon's hour at the top and bottom of the chart, the effect can easily be traced.

In order to connect several other features of the tide with this tide-producing force, it will be necessary to define more closely the moon's position and the variable orbit which she pursues.

The moon's orbit is inclined to the plane of the ecliptic about $5\frac{1}{4}$ degrees so that her latitude cannot exceed this quantity, but the earth's equator is inclined 23° 26′ to the ecliptic, thence the moon's declinations will vary from 0 to 28° 40′ north and south of the equator. The maximum declinations also vary by twice the latitude by reason that the nodes of the orbit are not constant but have a retrogade motion so that the moon may occupy every possible position in a zone of 10° 40′. The declinations will be greatest when the line of nodes coincides with the equinoctial line, for here the earth's declination plus the moon's latitude will be the moon's declination. These maximum declinations coincide with the moon's quadratures at the equinoxes and with the syzygies at the solstices, and vary between these points in the interval.

We have seen how the moon assumes various positions from south to north of the equator in each revolution about the earth, and we will find that the oceans are differently affected during inferior from superior transits. For we will first suppose the moon in the plane of the equator which occurs at new and full moon in the equinox and in the quadratures at solstices. It is evident that the moon holds the same relative position to the sea under her as the lower transit does to the sea on the remote side, and the result is the same; but when we consider the moon in maximum north or south declinations then the conditions are entirely changed; the lower transit of north declination and upper of south declination affect the sea further south than the upper north and lower south so that the results must be different for each pair. In order to illustrate, several tides of Cape Flattery on the Pacific coast are added to the sketch; these are sketched according to the reported observations of the U. S. coast survey.

The wave A 1 arrives arrives ahead of mean time after transit; B 1 is behind time; A 2 is separated one lunar day from A 1, and so on. These are the tides of max. decs. The tides A 1, A 2, etc., were formed by an upper transit with the moon at U, N. dec., or by a lower transit with the moon at L, S. decl., and the ocean at E will be affected alike by either; but since the line from the moon pierces the ocean north of the equator, the tide will be formed north of the mean origin and will come ahead of mean time. On the other hand, the tides B 1, B 2, etc., are formed by an upper transit with the moon at L, S. decl., or by a lower transit with the moon at U, N. decl., and the ocean at Q will also be affected equally by either; but since the line from the moon pierces the ocean south of the equator the tide will be formed south of the mean origin and will be behind time. The result is obvious; the wave B 1 being behind its proper place and the wave A 2 in advance, an overlapping takes place and the tides assume a mixed type. The tide travels by the rising of the water in front and the falling to the rear of the crest, hence the tide A in raising the rear slope of the tide B draws upon the volume and causes a degradation of the latter, the distance between B 1 and A 2 being greater than the mean interval, the

depression also becomes greater as the water which should belong to one is in part taken up by the other. If these intervals were not oscillating as they are; but continuous in pairs, the result would be the same as in inland lakes.

The highest spring tides should take place during the equinoxes when the oceans are affected alike for both upper and lower transits by the maximum force for several days in succession, but from four years careful observations I have found the mean rise and fall greatest during the five months, August to December inclusive; also the highest and lowest tides and maximum and minimum rise and fall from November to February inclusive.

The tides are known to rise higher as the moon approaches the earth. As the moon approaches, the common centre comes nearer the earth's centre and the centrifugal force increases as the moon's motion increases from its closer proximity, hence the tides increase. The tides on opposite sides, or corresponding to different transits of the moon, are practically alike when the moon is on the equator, now since the impulse on opposite sides is about as 500 to 900 the question will arise why the effect is not in proportion to the cause. As the pendulum will return nearly to the point from which it has fallen so these oscillations would also nearly repeat themselves, but since other waves approach to form the succeeding tide it is only necessary that the impulse should be repeated at the regular intervals necessary for equilibrium. There are those who deny the existence of the force at the side remote from the moon, but the inequality of the semidiurnal tides is sufficient to prove the existence of that force.

It has been stated that the force is nil at the moon's quadratures, then why any tides at these phases? The nil force exists but an instant and as before remarked, these oscillations will nearly repeat themselves even when they are changing with an increasing ratio as they change when approaching quadratures at the equinoxes, in fact Newton said, that when these oscillations were fairly established, the luminaries might be removed, and the tides would continue for an indefinite time. We also find that the effect does not immediately follow the cause, for the inverse order of tides does not take place for several days after change of

declination neither do the highest tides occur at full and change of the moon, nor the least tides in the quadratures.

A singular fact in nature, which is attributable to the tides, is the existence of the Sargossa seas in mid ocean. The tide in mid ocean is very small as has been ascertained at islands along the course of the tide. At the shores however, the tide is retarded and its range increased, so that the surface of the ocean is practically lower than its limits, forming a sort of settling basin whence the singular seas. A current chart by Bowditch shows a current from all directions towards the Sargossa sea in the Atlantic.

There is another question which arises and that is, why, if there is a primary tide in each of the southern oceans, there is not also the same in the northern oceans?

In the first place, the southern oceans are the largest and deepest and the effect produced upon them would preponderate over that produced on the smaller oceans. In the second place, the origin was not a matter of chance or choice but necessity, for as soon as the condensation of aqueous matter was sufficient to fill or to partly fill an oceanic basin, the tides began to move and as the oceans continued to increase, the motion was imparted to the increasing waters, the regularity of the impulse had the effect of producing the regular succession of tides of the oceans as the earth in its diurnal revolutions presented them successively to the tide producing force.

To sum up this investigation we have:

First. A primary tide in each of the southern oceans, and one in the Arctic ocean. These rise twice a day, and their appearance corresponds in time exactly with the moon's apparent motion. The semi-diurnal tides differ in magnitude with the moon's declination from the equator, showing that there is a tide force under the moon and also one on the remote side of the earth giving a tide following the inferior as well as the superior transit of the moon. The tides are greatest at the full and change and least at quadratures, and the range varies perceptibly with the distance of the moon.

Second. The moon revolves about the earth in an eliptical orbit, and by mutual attraction both revolve about a common

center. This common center is the point attracted by the sun and describes the orbit common to both bodies. The earth's center describes an undulating line, being part of the time within and part of the time without the common orbit. The common center is a variable point, on account of the variable attraction of the sun on the two bodies, and varies or fluctuates between the earth's center and the common center of gravity of the two bodies. The earth revolves about the common center with the same angular velocity that the moon revolves in her orbit.

The resulting eccentric motion of the earth begets a centrifugal force which coincides with the centrifugal force of the diurnal revolution only under and opposite to the moon in the plane passing through the moon. At other plates it tends only to deflect the line of gravity. When the common center coincides with the earth's center the force ceases, and is maximum when these points are at their greatest distance. When the moon approaches the earth her velocity increases, also the angular velocity about the common center, hence also the centrifugal force. This force tends also to move matter towards the equator in the plane of its activity.

From the foregoing argument the following is deduced as the cause of the tides:

In the first place it is evident that every phase and feature points direct to the moon as the cause of the phenomena, but in the next place the laws of nature show very clearly that the moon is only the implement by which the superior controlling force operates, the moon's efforts as the satellite of the earth being due to the sun's influence. The sun is therefore the prime cause operating in accordance with the grand principle discovered by the great Newton and announced to the world 193 years ago, the principle of UNIVERSAL GRAVITATION.

ON A PROPOSED SYSTEM OF LITHOLOGICAL NOMENCLATURE.

By T. C. CHAMBERLIN, Ph. D., Director of the Wisconsin Geological Survey.

That our present system of lithological nomenclature is in some important respects unsatisfactory, it is needless to assert. It is inadequate, in that it falls far short of properly designating all the mineral aggregates that have now become subjects of description, and of not infrequent reference in geological literature. It is ambiguous, in that certain terms in common use are differently used by different writers. So common a term as *syenite*, and the not infrequent ones *melaphyr* and *gabbro*, are striking examples. It is inaccurate, in that it groups under the same term, rocks whose ultimate chemical composition varies widely, or those whose origin is diverse. It is mischievous, in that the individuality of its naming inevitably implies hard and fast lines which do not exist in nature. It is etymologically objectionable, in that terms are wrested from their derivative sense, and forced into incongruous applications. Thus the term granite is driven from its popular, and, as it happens in this case, proper application to a wide class of *grained* crystalline rocks, and restricted to a certain *mineralogical* aggregation.

That these objections are felt in greater or less degree is shown (1) by the *drift* in the signification of terms, (2) by the efforts made to restrict and define old terms, (3) by the introduction of new terms, (4) *by the compounding of terms, and* (5) *by the use of mineralogical names as defining adjectives.* As examples of compounding may be cited such terms as quartz-syenite, oligoclase-trachyte, quartz-augite-andesite, labradorite-diorite, hornblend-andesite, dioritic-gneiss, hornblendic-biotite-gneiss, and so on through the long list of complex terms that characterize the later and more precise lithological discussions.

The essential features of the proposed system lie in the direction of this manifest tendency, and consist, essentially (1), in an

effort to separate lithological terms into distinct classes, having reference to the several different attitudes from which the character of rocks may be viewed, as physical, chemical, mineralogical, petrographical; and (2), the introduction of a series of contractions, and a system of compounding terms, which shall render lithological names at once specific, self-explanatory and measurably quantitative. At the same time the mischievous implications attached to prevalent terms, fashioned after those applied to definite mineralogical species, are avoided.

Lithological terms are either adjective or nominal in character, and a complete series of each would greatly facilitate expression.

The following classification of terms, embracing mainly those already in use, will make more clear the place and function of the changes and additions proposed:

LITHOLOGICAL TERMS.

A. ADJECTIVE.

Class I. Basis of Classification — The Physical Nature of the Constituents.

1. Fragmental. (Detrital, Clastic.)
   - Conglomeratic.
   - Sandy or arenaceous.
   - Clayey or argillaceous.
   - Compact, etc.
2. Crystalline.
   - Granular or phanero-crystalline.
   - Crypto-crystalline.
   - Porphyritic, (the above combined.)

Class II. Basis of Classification — The Structure of the Mass.

Massive.
Schistose.
Shaly.
Slaty.
Laminated, etc.

Class III. Basis of Classification — Coherence.

Tenaceous, firm, compact, etc.
Incoherent, friable, uncompacted, etc.

Class IV. Basis of Classification — Chemical Nature.

Silicious.
Calcareous.
Ferruginous.
Carbonaceous, etc.

Class V. Basis of Classification — Mineral Constitution.

Quartzose.
Micaceous.
Pyritiferous.
Garnetiferous.
Staurolitic.
Chloritic, etc.

Class VI. Basis of Classification — Lithological Character.

Granitic.
Basaltic.
Dolomitic.
Porphyritic.
Trachytric.
Dioritic, etc.

Class VII. Basis of Classification.— Origin.

Igneous,
Aqueous,
Metamorphic,
Pseudomorphic,
Eolian, etc.

B. NOMINAL.

Class I. Basis.— Physical Form of the Constituents, (Mainly.)

Conglomerates: Pudding stone. Gravel, (incoherent conglomerate). Breccia.

Grit, grit-rock, sand, sandstone, sandrock.
Clay, mud, silt, earth, alluvium, soil,
Till,
Tufa, etc.

Or, again,

Crystallites,
Clastites,
Aggregites,
Amorphites.

The terms of the last named group may be defined as follows:

Crystallites, those rocks that are crystalline in structure;

Clastites, those which are fragmental or detrital in origin;

Aggregites, those which are simply accumulations of individualized particles of matter, coherent or incoherent, neither crystalline nor detrital in origin, as infusorial earth, or chalk, when it is composed of uncomminuted Rhizopod shells;

Amorphites, those rocks in which there are no discernible individualized constituents.

Class II. Basis of Classification.—Structure of the Mass.

Schist,
Shale,
Slate, etc.

Or, again,

Stratified,
Unstratified.

Class III. Basis of Classification.—The Crystalline Character of the Constituents.

Granite, (crystals distinct).
Granulite, (crystals minute).
Aphanite, (no visible crystals).
Porphyry, (crystals in compact base).

It is proposed to restore the term *granite* to a proper etymological use, and apply it to rocks consisting of distinct, crystalline grains of medium or large size, and to deprive it of mineralogical signification, making it a term denoting simply a certain class of crystalline aggregates.

It is proposed to designate minutely granular crystalline rocks,

by the diminutive term *granulite*. *Aphanite* may then be more freely used to include all crypto-crystalline rocks, while *porphyry* will embrace combinations of the last with the two former.

Class IV. Basis of Classification — Physical Characters.

Trachyte.
Rhyolite.
Pumice.
Scoria.
Phonolite.
Buhrstone.
Pearlstone, etc.

Class V. Basis of Classification — Origin.

Lava.
Trap.
Meta (——.)
Igno (——.)
Aguo (——.)

There is a very prevalent, and, for the most part, just prejudice against the use of the name *trap*, arising from the frequent use of the term as though it conveyed a mineralogical signification, whereas the term really has none, and, in its proper application, includes rocks of various mineralogical and chemical constitution. But this abuse is really but an aggravated instance of what is common, indeed, almost universal, under the present system of nomenclature. To merely specify that a rock is granite, may be to use that term as a "cloak of ignorance" in the same sense, though perhaps not to an equal degree, as to rest with the assertion that a rock is a "trap;" for the term granite embraces a scarcely less wide range of minerals or of ultimate chemical constituents, and the wresting of the term from its primitive and proper application, is scarcely less violent. If, however, the term *trap* be stripped of all pretension to mineralogical signification, and confined to the simple designation of rocks formed of matter that issued through fissures, either constituting dikes, or spreading out into sheets, and so incidentally giving rise to step-like topog-

raphy, as distinguished from *lavas* that have arisen from craters and flowed away in radial streams, with the attendant structural distinctions between the two, it will serve a convenient function in the literature of the subject, without being a "cloak of ignorance" in any other sense than *lava* is, or many other general, very convenient and necessary terms.

There will, doubtless, arise many cases in which it will be impossible to determine the method of issuance of a given igneous rock, and neither the term *lava* nor *trap* could be used in the restricted sense here proposed, and there may be little fundamental distinction between the phenomena in the two cases; but both the distinction and the terms are serviceable in geological literature, when stripped of the pretentious clothing to which they have no title.

Prof. Dana has suggested that metamorphic rocks be designated by the prefix *meta*. If this were generally adopted it would doubtless be serviceable; but the limitations of knowledge being such as they are, it would seem almost necessary to introduce a corresponding prefix to indicate similar rocks of igneous or aqueous origin. For if the simple name, as diorite for example, be understood to imply igneous origin, and the compound term, as meta-diorite, a metamorphoric one, it would be necessary, in the *very naming of the rock*, to assert an opinion as to its origin. But in many cases it is impossible to positively determine the origin of a rock, whose other characteristics may be very well known; and there would be no convenient term to express this knowledge, without implying knowledge not possessed. In respect to granite, for instance, it is contended, severally, by able geologists, that it may have an igneous, an aqueous, and a metamorphic origin, and yet, in many instances, the working geologist would not feel at liberty to assert that a given granite belonged to either class; and it would be a sore inconvenience to be obliged to make an implied assertion upon the subject, or else be shut out wholly from the use of the term granite. If, therefore, the system of introducing prefixes to designate origin be adopted at all, it should be complete, and yet leave the working geologist at liberty to use the fundamental term, free from the added signification.

It is hence suggested that the term *meta-* be used as a prefix, when it is desired briefly and conveniently to assert a metamorphic origin; that the prefix *igno-* be used similarly to assert an igneous origin; and *aquo-* in like manner, to imply an aqueous origin; while the simple terms shall have merely their own mineralogical, or other appropriate, signification.

Class V will then embrace the terms, lava and trap, used to designate rocks of certain special eruptive origins, and a long list of terms to which the prefixes *meta-*, *ingno-* and *aquo-* are attached to signify, respectively, metamorphic, igneous and aqueous origin.

The foregoing terms furnish fair, though somewhat inadequate, facilities for the designation of the several classes of properties indicated under the headings. There remains to be added a series of terms which shall express the mineralogical constitution of rocks, which is by far their most important characteristic. It is in respect to this that our present system is weakest, and, from the fact that it attempts to impose fixed names upon indefinitely varying aggregations, must necessarily ever remain unsatisfactory. It is, therefore, proposed to escape this difficulty by the use of a system of flexible compound terms, which shall admit of variation to express varying composition, and, roughly, the varying quantitative relations of the mineral ingredients. As above indicated, the growing tendency in lithological literature is toward the employment of compounds of mineralogical names. The advantage of this, in clearness and precision, as well as in the convenience of the reader, is manifest. But it results in cumbersome terms, and if carried sufficiently far to overcome the defects of the present system, becomes burdensome. This, however, may be obviated by a series of contractions which shall retain a significant portion of the mineralogical name, without the burden of its entirety. For the sake of euphonious combinations, these contractions may be varied somewhat in their several combinations. The following are suggested as available abbreviations of the names of the leading minerals that enter into the composition of rocks, and it will not be difficult to extend the list to any other minerals that may, in given instances, become prominent lithological constituents.

Abbreviations of the Names of Minerals Constituting Rocks.

Quartz — Qua., or qu.
Feldspar — Fel.
Orthoclase — Orth., or ortho.
Microcline — Micr., or micro.
Oligoclase — Olig., or oligo.
Labradorite — Lab., labra., or labrad.
Albite — Al., alb., or albi.
Andesite — And., or ande.
Nephelite — Neph., or nephe.
Leucite — Leuc., or leuci.
Sodalite — Soda., or sodal.
Mica — Mi.
Muscovite — Musc., or musco.
Biotite — Bio., or bi.
Hydromica — Hydrom., or hydromi.
Amphibole — Amph., or amphi.
Hornblende — Horn., or 'orn.
Actinolite — Act., or actin.
Smaragdite — Smar., or smara.
Tremolite — Trem., or tremo.
Pyroxene — Pyr., pyro., or pyrox.
Augite — Aug., or augi.
Sahlite — Sahl.
Diallage — Dial.
Hypersthene — Hypers., or hypersth.
Saussurite — Saus., or sausu.
Epidote — Ep., epi., or epid.
Garnet — Gar., garn., or garne.
Chrysolite — Chrys., or chryso.
(Olivine — Oliv., or olivi.)
Calcite — Calc., or calci.
Serpentine — Serp., or serpe.
Chlorite — Chlo., or chlor.
Pyrite — Pyri., or pyrit.
Magnetite — Mag., magn, or magne.

Hematite — Hem., or hema.
Menaccanite — Menac., or menacca.
Tourmaline — Tour., or tourma.
Graphite — Graph., or graphi.
Apatite — Ap., or apa.
Andalusite — Andal., or andalu.
Cyanite — Cy., or cyan.
Sericite — Seri., or seric.
Zircon — Zir., zirc., or zirco.

In the combination of these it is suggested that the leading constituent stand first, and that the remaining constituents follow in the order of importance. In crystalline rocks there will often be present minerals in small and varying quantities, which it will be neither convenient nor desirable to include in the compound name of the rock, but which should be regarded, as they commonly are, as accessory minerals. There may be little philosophical basis for this distinction, since the rock is at best but an aggregate, and is what it is by virtue of the total aggregation, and not by virtue of any definite composition, as in the case of a mineral or chemical compound. Nevertheless, these minor mineral constituents do not, in the main, represent any distinctive condition in the formation of the rock, but rather some of those accessory circumstances common to a wide range of rock-formations. They are, therefore, geologically incidental, rather than essential, conditions, and their products may, therefore, be omitted from the compound name and classed as accessory minerals, and as such receive attention in exhaustive descriptions, without burdening the more general discussions. It will of course be within the discretion of each writer, in the case of a given rock, to decide what are its essential and what its trivial constituents.

In this system no uniform terminal syllable is proposed. It may be doubted whether lithologists will take kindly to this innovation, since it is at variance with the prevalent custom of terminating rock names with an *ite* or an *yte*, after the fashion of mineralogical terms. A grave objection to the usage, however, arises out of the very fact of this imitation, since it implies, in the rock-aggregation, something of the same definiteness of constitution that the mineral possesses; and this, I believe it is universally conceded,

is a false and mischievous idea. It seems to the writer, therefore, best that the name should imitate the complex aggregation of the rock which it designates, rather than the individualized character of a mineral to which it has only the semblance, not the substance, of a true likeness. The first, therefore, of the following series of proposed names will consist of a bare aggregation of abbreviations of the names of the mineral constituents of the given rocks, in the order of their relative importance, thus both representing and defining the rock without pretension to individualization. The oddness of the names may at first be mistaken for uncouthness, which will indeed be justly chargeable in some cases, but the quaint elegance of other instances will offer some, if not full, compensation. The uniformity — not to say monotony — given by the fashionable suffix will be lost, but a vivacious variety will be gained.

An alternative series, however, is proposed, more in harmony with the present habit, both in respect to uniformity of termination, and the order of arrangement of the constituents, which is that of the inverse order of importance, the most abundant mineral being last and receiving the termination. The suggestion of Prof. Dana in respect to a distinctive orthography is here adopted.

The application of the system may be illustrated by the familiar rock granite. Its composition is generally stated as quartz, feldspar and mica. Assuming, for the moment, that no more precise statement is desired, and that the relative amounts of the ingredients are in the order given, its name under the first form of the proposed system will be qua-fel-mi (quàfelmi). If, however, as is very frequently the case, feldspar is the leading ingredient, and quartz second in order of importance, the name will be fel-qua-mi (fèlquami). Should mica stand second in importance, the formula would be fel-mi-qua (fèlmiqua , and so on for other variations. In this instance, mica rarely assumes the leading place without removing the rock from the present category of granites. But under the proposed system the nomenclature will strictly adhere to the mineralogical constitution and the compound terms mi-fel qua (mi-felqua), and miqua-fel (miquafel), will represent the preponderance of mica in this mineral aggregation, and the structure will be represented by an appropriate adjective, as

foliated mifelqua, or schistose miquafel, or miquafel schist, or otherwise, as the case may be.

But the mere indication that the granite is compossd of quartz, feldspar and mica, may be quite too general for precise discussions, since it does not indicate which feldspar, nor which mica, nor whether more than one of either or of both is present. The more precise of the text-book definitions of granite rarely go beyond the statement that it is composed of quartz, orthoclase and mica. If this is the degree of precision chosen to be asserted the new terms will be, qu'orth-mi (quórthmi), ortho-qua-mi (orthóquami), mic-ortho qua (mic rthoqua), qua-mic-orth (quámicorth), ortho-mi-qua (orthomiqua), or mi-qu'orth (miquórth), according as the relative proportions may be. But the mica, instead of being common muscovite, which would doubtless be understood by the general term, may be biotite. In this case the names will be qu'ortho-bio (quórthobio), ortho-qua-bio (orthcquábio), bi-ortho-qua (biórthoqua), and so on, according to the relative proportions.

By modifications of the abbreviations which will not destroy their distinctive, representative character, difficult vocal combinations may, for the most part, be avoided, and euphonious terms secured. The system, it will be observed, is quite analogous to that adopted by chemists to meet the complexities of carbon compounds, but will rarely need to approach it in cumbersome combinations.

Under the alternative system proposed, similar combinations will result, but the order will be reversed, and the termination *yte* added to the leading constituent. When the usual order of naming the constituents of granite,—quartz, feldspar and mica—represents the relative abundance of the constituents, the name will be mi-fel quartzyte (mifelquartzyte). This extension of the use of the the term quartzyte appears not unjustifiable when it is considered that, in addition to the preponderance of free quartz, silica forms a large constituent of the remaining ingredients; and that there is a not uncommon class of rocks, intermediate between the old classes quartzyte and granite, to which such a term would be happily applicable. But among the granites feldspar is often the leading constituent. The name will then be mi-qua-felsparyte (micafelsparyte). The more precise names will be mic-ortho-

quartzyte), mi-qu'orthoclastyte (miquorthoclastyte), qu'ortho-micatyte (quorthomicatyte), qua-mic-orthoclastyte (quamicorthoclastyte), ortho-mi-quartzyte (orthomiquartzyte), ortho-qua-micatyte (orthoquamicatyte), bi-ortho-quartzyte (biorthoquartzyte), bio-qu'orthoclastyte (bioquorthoclastyte), qu'ortho-biotyte (quorthobiotyte), qu'ortho-muscovyte (quorthomuscovyte), etc.

The foregoing, perhaps, sufficiently illustrate the method of the system, its extreme flexibility, and consequent adaptiveness to the variations of rock combinations, the self-definitiveness of the terms, and their monemonic advantages with students, as well as, on the other hand, something of the cumbersome complexity and quaintness which will sometimes arise where exact momenclature is attempted. In the following lists no attempt is made to exhibit the complete variation under the several rocks, but simply to give leading names under the two systems, assuming, usually, that the common order of naming the ingredients is that of their relative abundance. The verbal combinations that would arise with other proportions can readily be constructed.

Class V. Basis of Classification — Mineral Composition.

Present Names.	First Proposed Form.	Second Proposed Form.
Limestone.....	Limestone, or.....	Calcityte.
Dolomite..	Dolomite	Dolomyte.
Quartzite...	Quartzite..	Quartzyte.
Granite	Qua-fel-mi, or.....	Mi-fel-quar'zyte, or
.....	Qu'-orth-mi.....	Mic-ortho quartzyte.
.....	Ortho qua-mi.....	Mi-qu'orthoclastyte.
... .	Qu'-ortho-bio.....	Bi-ortho-quartzyte.
.....	Qu' ortho-musc	Musc-ortho-quartzyte.
.....	Ortho-qua-musc, etc.....	Musc-qu'orthoclastyte, etc.
Granulite..... ..	Fel-qua, or	Qua-felsparyte, or
.....	Qua-fel	Fel-quartzyte.
Gneiss	Foliated fel-qua-mi.....	Foliated mi-qua felsparyte.
....	Foliated fel-mi-qua.....	Foliated qua mi-felsparyte.
.....	Foliated qua fel mi	Foliated mi-fel-quartzyte.
.....	Foliated qua-mi-fel, etc...	Foliated fel-mi quartzyte, etc.
Mica schist.....	Schistose mi-fel-qua, or ..	Schistose qua fel-micatyte.
.....	Schistose miqua-fel	Schistose fel-qua-micatyte.
Hydromica Schist .	Schistose Hydro-mi-qua-fel, etc	Schistose fel qua-hydromicatyte.
Protogine	Qu'-orth-michlor.....	Chlor-mic-ortho quartzyte.
Minette	Ortho-bio	Bi-orthoclastyte.
Greisen	Granular qua-mi	Granular mi-quartzyte.
Felsite	Felsit	Felsyte.

Class V. Basis of Classification — Mineral Composition — con.

Present Name.	First Proposed Form.	Second Proposed Form.
Quartz-felsite	Felsi-qua	Qua-felsyte.
Leucitite	Leucitite	Leucityte.
Kersantite	Bi-olig	Oligo-biotyte.
Kinzigite	Bi-olig-'ar	Garn-oligo-biotyte.
Miascite	Micro-nephe-soda-bio	Bio-soda-nephe-microclinyte.
Ditroite	Micro nephe-sodal	Soda-nephe-microclinyte.
Syenite	Orth-'orn, or	Horn-orthoclastyte, or
	Orth-amph	Amph-orthoclastyte.
Quartz-Syenite	Orth-'orn-qua, or	Qu-'orn-orthoclastyte, or
	Orth-amphi-qua	Qu-amph-orthoclastyte.
Syenite Gneiss	Schistose Orth-'orn	Schistose Horn-orthoclastyte.
Hornblende Schist	Schistose Hornblendite	Schistose Hornblendyte.
Amphibolite	Amphibolite	Amphibolyte.
Actinolite	Actinolite	Actinolyte.
Unakite	Ortho-qu'-epido	Epido-qu'-orthoclastyte.
Foyaite	Ortho-neph-'orn	Horn-'eph-orthoclastyte.
Diorite	Alb-(h)orn, or	Horn-albyte, or
	Horn-alb	Alb-hornblendyte.
	Labrad-(h)orn	Horn-labradoryte.
	Olig-(h)orn, or	Horn-oligoclastyte, or
	Horn-olig	Olig-(h)ornblendyte.
	Anorth-'orn, or	Horn-anorthyte, or
	Horn-anorth	Anorth-'ornblendyte.
	(Amphi-lab)	(Lab-amphibolyte).
	(Amph-anorth)	(Anorth-amphibolyte)
Quartz Diorite	Alb-(h)orn-qua	Qu' 'orn albyte.
	Horn albi-qua	Qu'-alb-hornblendyte.
	Olig-(h)orn-qua	Qu'-'orn-oligoclastyte.
	Horn-oligo qua	Qu'-olig-hornblendyte.
Andesite	Andesite, or	Andesyte.
	Ande-horn	Horn-andesyte.
Dacite	Ande-horn-qua	Qu'-orn andesyte.
Corsite	Anorth-'orn	Horn-anorthyte.
Euphotide	Saus-'mar, or	Smara-sausuryte.
	Saus-dial	Dialli sausuryte.
Gabbro	Labro-dial, or	Dial-labradoryte.
	Dial-lab	Labro-diallagyte.
Augitic-andesite	Ande-aug	Augi-andesyte.
Norite	Labra-pyr	Pyro-labradoryte.
Hypersthenite	Labr-yperth	Hyperth-labradoryte.
Dolerite	Labrad aug, or	Augi-labradoryte.
	Lab'r'-aug	
Diabase	Lab'ad-aug, or	Augi-labradoryte.
	Labr' aug	
Eucrite	Anorth-aug	Augi-anorthyte.
Amphigenite	Augi-leuc	Leuci-augyte.
Nephelinite	Augi-neph	Neph-augyte.
Eclogite	Horn-garni-smar	Smara garni hornblendyte.
Epidosite	Epido-qua	Qu'-epidotyte.
Eulysite	Chryso-dial-garn	Garne-diallo-chrysolyte.
Picrite	Chrys-aug	Augi-chrysolyte.
Ophiolite	Serpe-calc	Calc-serpentyte.
	Serpe-dol, or	Dolo-serpentyte, or
	Serpe-mag	Magne-serpentyte.

In pronunciation, the accent should be placed upon such syllables as will best retain the original sounds of the abbreviations, so far as convenience of utterance will permit.

Since a gradual transition, advantageous at all stages, is to be preferred to a sudden revolution, it is suggested that the new terms may be introduced in lithological discussions in parenthesis after the usual names. The new terms will thereby not merely serve as definitions of the old as used, but as succinct statements of the composition of the special rocks described, which is often but vaguely indicated by the common names. This will often permit a shortening of descriptions, and will certainly foster precision of observation and statement, while (if a brief explanation of the system and a list of abbreviations are given until they become well known) it will greatly serve the convenience of students, semi-scientific readers, and not a few geologists who may not be specialists in lithology and freshly familiar with its terms. The system would thus have opportunity to perfect itself while growing into general use.

WATER PUPPY.

(*Menobranchus lateralis say.*)

By P. R. Hoy, M. D.

DESCRIPTION.

Entire length of large female 14 inches. Head 2 inches long and 1¾ broad. Body, including head, to vent, 10 inches. Tail 4 inches to vent; breadth of tail, 1¾. The male smaller, from 10 to 11 inches in length. Head large, flattened above. Snout truncated. Eyes small, placed far apart. Nostrils lateral, near the margin of the upper lip. Two rows of small teeth in the upper, and one single row in the lower jaw. Mouth large. Lips fleshy. Tongue broad, entire, free at the point. Neck contracted and provided with a deep cutaneous fold at the throat. Three rows of external plumose gills on each side, they are placed on the posterior margin of a corresponding fleshy prolongation, and supported by three branchial arches between which there are two gill openings into the mouth somewhat fish like. Body elongated and stout, covered by a soft skin, permeated by many pores. Tail broad, flattened, emarginated eel-like. Feet four, all have four toes each without nails, vent a longitudinal fissure. Color light brown, with numerous dark spots and blotches, beneath lighter, with fewer and smaller spots. Heart two-chambered. Lungs rudimentary, *not functional.* Eggs large and much like those of fish. This species of menobranch inhabits large rivers and lakes in the northern states, especially numerous in Lake Michigan. They feed on small fish, crustaceans and molusks. They frequently commit depredations on the spawning beds of fish, and thus doing considerable damage.

They inhabit rather deep water with stony bottom, over which they crawl in search of prey. They seldom, or never rise to the surface. They swim with considerable velocity, however, when occasion requires. They take the baited hook, and dire is the consternation of the boy who hooks the fish with legs. I have little doubt that the flesh is well flavored and nutritious; certainly it is true that when a cat once gets a taste of the flesh of the water puppy it is well nigh crazy to repeat the experiment In

nature the menobranchus occupy nearly the lowest place among Amphibians, which class stands between fish and reptiles. Physiologically they are fish having legs in place of fins, if such a monstrosity could be admitted in *fish aristocracy!* They cannot live out of water as long as some other fish, for the reason that the gills are exposed and dry more readily in consequence. If the body is kept moist life is sustained for a greater length of time, proving that aeration is, to a slight degree, carried on through the skin.

It is an interesting fact that the early tadpole stage of salamanders resemble the adult menobrach. In early life the Amblistoma lurida — the life history of which I have carefully studied — is strictly aquatic, has a tricamerate heart and rudimentary lungs. However, when the legs and feet are being developed the gills begin to wither and the lungs to assume functional duty, imperfect as yet though it may be. The second auricle to the heart is now being developed in this transition stage. In this condition the young salamander has been considered a privileged animal — that while in water branchial respiration was sufficient, and again, when on land pulmonary respiration was all sufficient — a perfectly amphibious animal. But we may withhold our admiration of this privileged condition, for in fact it cannot live in, or out, of water, the gills being partly absorbed, while the yet imperfectly developed lungs render aerial respiration quite imperfect. So the poor animal has to come to the surface for a mouthful of air and plunge back into the water in order thus to secure the full benefit of the imperfect gills; so they have to play at shuttlecock from one element to the other, not being able to live in either element alone. I am persuaded that the central organ of the circulation (the heart) indicates the mode of respiration, as no air-breathing vertebrate has less than three chambers in the heart, and no aquatic vertebrate has more than a two-chambered heart. Now as the menobranch cannot live out of water — is strictly aquatic — has only branchial respiration — reason sufficient to prove that they are provided with a bicamerate heart. On dissection we found the two-chambered heart, as anticipated. In studying the salalemanon I found when a leg was amputated it

would be reproduced in precisely the same manner — toes appeared in like order, as in the original development. But if a branch of the gill was removed it was not reproduced, for the reason, it would seem, that the gills were only a temporary organ, only to serve the animal during its embrionic state, while if the feet were to serve the animal through the adult state, their reproduction became a necessity. But, we anticipate, when we clip off a portion of the gills of the menobranch, those portions amputated, that portion was reproduced promptly, so that in three weeks the gills were again perfect. The gills being essential to adult life, they were restored. The water puppy is a most beautiful object, as it appears in its favorite surroundings, with the long scarlet plumose gills, continually waving backwards and forwards. The behavior of the menobranch when confined in an insufficient quantity of water is interesting. As the oxygen becomes exhausted, the animal rises to the surface, opens the mouth and takes in a portion of air, bubbling it out through the gill openings, thus bringing a portion of air in contact with the gills, or rather by this movement the water is aerated, near the surface, precisely as do fish in similar circumstances. I have frequently seen puddles of water, where the mud fish, *melanura limi*, abounded, entirely covered with small bubbles formed by these hardy fish in their partially successful efforts to obtain a sufficient amount of oxygen.

THE PIPESTONE OF DEVIL'S LAKE.

(Read before the Wisconsin Academy of Sciences, Arts, and Letters, February 14, 1877.)

By E. E. Woodman, Baraboo.

A rock found in the vicinity of Devil's Lake has not, so far as I am aware, been properly classified. The local and popular name for it is soapstone, derived, doubtless, from several qualities which it possesses in common with steatite, and especially the greasy feel of that mineral. From the presence of the elements of soapstone it is talcose, but the primary object of the present paper is to identify it as an argillite of the variety called pipestone.

Two specimens are herewith presented. The red one is from the widely known quarry in south-western Minnesota, the other from the neighborhood of Devil's Lake, Sauk county, Wisconsin. On a superficial examination they will be found to possess several properties in common. In their feel, hardness, susceptibility to polish, earthy odor when moistened, freedom from grit, in most of their obvious properties except color, they agree. Also their behavior before the blow-pipe is the same, both being infusible without a flux, but with borax yielding a green glass. In these characteristics they answer to the description which Nicollet (Itinery 1842, Senate Document No. 237) gives of the red pipestone of Minnesota, as quarried under his personal direction and observation: "Compact; structure slaty; receiving a dull polish; having a red streak; color blood red, with dots of a fainter shade of the same color; fracture rough; sectile; feel somewhat greasy; hardness, not yielding to the nail; not scratched by selenite, but easily by calcareous spar; specific gravity 2.90. The acids have no action upon it; before the blow pipe it is infusible *per se*, but with borax gives a green glass."

I am indebted to Prof. W. W. Daniells, of this Academy, for a qualitative analysis of these specimens which completes the evidence of their identity. He finds the principal component of each to be silicate of alumina. This is combined with small percentages of lime, magnesia and oxide of iron, the last being a larger constituent of the red than of the gray specimen, as might be inferred from its color. The specific gravity of the red speci-

men is by his determination 2.752; and of the gray one, 2.829. The agreement in this regard also is quite close, though perhaps accidental; for Nicollet's determination of 2.90 for the red variety shows that specimens from the same quarry may vary considerably in this particular; and so, likewise, they do in color. The stone from the Minnesota quarry is not uniformly of the blood-red color on which the species *Catlinite* is founded, but often is mottled with lighter shades of red, running into yellow; while that from Devil's Lake, as thus far discovered, is all variegated, gray, black, yellow and red being intermingled in the same specimen, producing the veined appearance of some marbles. One part of the gray specimen here submitted gives a red streak undistinguishable from that of the red specimen, and I have seen specimens from Devil's Lake in which the dark color greatly predominated, though such examples are as yet rare. This diversity in weight and color indicates that a quantitative analysis of specimens from different sources would be scarcely more valuable, as a means of identification, than a qualitative one. I however take from *Silliman's Journal*, 1839, the only analysis to which I have access, that of the Minnesota pipestone, by Dr. Jackson of Boston:

	Grains.
Water	8.4
Silica	48.2
Alumina	28.2
Magnesia	6.0
Perox. Iron	5.0
Ox. Manganese	0.6
Carb. Lime	2.6
Loss (probably magnesia)	1.0
	100

The carbonate of lime is not an essential ingredient, but is mixed in fine particles.

It will be noticed that this formula agrees, in the general way, with the qualitative results by Prof. Daniells.

I was led to conjecture the true character of this rock from an examination, made in 1869, of the quartzite of the falls of the Big Sioux, in Dakota Territory, where the town of Sioux Falls has since been built. That outcrop is reported to be the same

with the formation containing the pipestone of Minnesota, only forty miles distant, and is identical in its aspects with the quartzite of Devil's Lake. It has the same color, hardness, completeness of metamorphism, ripple marks, and tendency to degrade in cubical forms; the last a notable feature of the rock at Devil's Lake and equally characteristic of the quartzite in which the Catlinite is found, as it is described by Nicollet. These localities have not only the quartzite apparently identical, but also the pipestone. I found a mottled, yellow and red pipestone cropping out at the Big Sioux, associated with the quartzite. A fourth location of the pipestone, noted by Nicollet and later by Owen, is at the head waters of the Cedar, a tributary of the Chippewa, on Sec. 27, T. 35 N., R. 10 W., of the public survey, as I am informed by the owner of the land, Mr. H. C. Putnam of Eau Claire. Here, too, it is associated with quartzite.

The concurrence of these facts suggested to me the importance of identifying the talcose beds of Devil's Lake with the pipestone of the other localities. Pipestone is a rare rock. Its appearance in these widely separated centers, with like associations, I take to indicate a common age and origin for the containing quartzites, respecting which there has been much discussion and still exists a diversity of views. It would seem to have been satisfactorily determined by Prof. Irving that the quartzite of Devil's Lake is older than the Potsdam sandstone. The junction of the quartzite with the inferior formation has not been discovered in any of the localities herein mentioned. That evidence would be conclusive of the question in the particular case. While awaiting it, some authorities refer the Minnesota and Dakota formation to the Potsdam and others to the Huronian period. My thought is, that whatever the age of one of these formations, all are referable to the same epoch; that they are allied by the pipestone; and that this connecting link establishes the probability that these rocks are the result of the same cause or set of conditions, operating in that dawn of the continent's history when literally the dry land first appeared.

In the vicinity of Devil's lake the pipestone is found in but few places, and the exposure is nowhere extensive. It conforms

to the Minnesota and Dakota outcrops in the thinness of the beds. The stratum from which the specimen herewith submitted was taken is perhaps eight inches thick, intercalated between heavy layers of quartzite, and was uncovered in the course of excavating a railroad borrow-pit. As quarried it is quite brittle, so that large pieces are obtained with difficulty. It hardens considerably as the moisture dries out. If an exposure should be discovered in which the stone was cheaply accessible over a considerable area, it would possess a commercial value for the ornamental uses which will readily suggest themselves to one who examines a dressed specimen. The stone has been somewhat used as a material for tobacco pipes by present residents of the locality, but no systematic effort to utilize it has been made, for the reasons indicated. Shortly before I was at Sioux Falls, then Fort Dakota, some white men had poached upon the Minnesota pipestone reservation to their considerable profit, it was said. They set up turning lathes at the Fort, and, transporting supplies of the red stone from the quarry with teams, applied machinery to the manufacture of the calumet, which they modeled upon the Indian hand-made article. They shipped the finished product to some military post on the upper Missouri by a supply steamer, and there bartered it with the red men for pelts and skins, to the great advantage of both parties possibly, and of the whites probably, if not certainly.

THE LARGER WILD ANIMALS THAT HAVE BECOME EXTINCT IN WISCONSIN.

(Read at the Racine meeting.)

By Dr. P. R. Hoy.

A record of the date and order in which native animals become extinct within the bounds of any country is of present interest, and in the future may be perused with redoubled satisfaction.

Fifty years ago the territory now included in the state of Wisconsin was nearly in its primitive condition. Then many of the larger wild animals were abundant. Now all has changed; the ax and plow, gun and dog, railway and telegraph, have completely metamorphosed the face of nature. Not a few of the large quadrupeds and birds have been exterminated or have hid themselves away in the wilderness of northern Wisconsin.

There was a time, away back in the dim past, when the mastodon, ox, elephant, tapir, peccary, and musk-ox roamed over the ancient prairies of Wisconsin, but now only their bones, from time to time, are exhumed and thus exposed to the wondering gaze of the ignorant many and the trained eye of the wiser few. We shall at this time, however, confine our attention to the historic period.

The antelope, *Antilocarpa Americana*, now found only on the western plains, did, two hundred years ago, inhabit Wisconsin as far east as Lake Michigan. In October, 1679, Father Hennepin, with La Salle and party, in four canoes, coasted along the western shore of Lake Michigan. In Hennepin's narrative he says: "The oldest of them" [the Indians] "came to us the next morning, with their calumets of peace, and brought some *wild goats*." This was at or near Milwaukee. "Being in sore distress, we saw upon the coast a great many ravens and eagles, from whence we conjectured there was some prey, and having landed on that spot we found above the half of a fat wild goat which the wolves had strangled. This provision was very acceptable to us, and the rudest of our men could not but praise the Divine Providence which took so particular care of them." This was, undoubtedly, near Racine. "On the 16th" [October 16, 1679] "we met with abundance of game;

a savage we had with us killed several stags and *wild goats*, and our men a great many turkey, very fat and big." This last point was between Kenosha and Racine. Hennepin's goats were without doubt antelopes. Father Joliet, a little earlier, mentions that "on the Wisconsin there are plenty of turkey cocks, parrots, quails, wild oxen, stags and wild goats." All species of the deer family were called stags by the early travelers. Schoolcraft mentions antelopes as occurring in the Northwestern Territory, and as late as 1850. Antelopes were not uncommon in southern Minnesota, only forty miles west of the Mississippi river. It is evident, then, that antelopes have retired quite leisurely.

When the last buffalo, *Bos. Americana*, crossed the Mississippi is not precisely known. Governor Dodge told me that buffalo were killed on the Wisconsin side of the St. Croix river the next year after the close of the Blackhawk war, which would be 1833. So Wisconsin had the last buffaloes east of the Mississippi river.

The Woodland Caribon, *Rangifer Caribou*, were probably never numerous within the limits of the state. A few, however, were seen near La Point in 1840; none since.

Elk, *Cervus Canadensis*, were on Hay river in 1863, and I have but little doubt that a few still linger with us. The next to follow the buffalo, antelope and reindeer.

Moose, *Alce Americanus*, continue to inhabit the northern part of the state, where they still range in spite of persecution. A fine cow moose was shot near the line of the Wisconsin Central Railway in December, 1877.

A few panthers, *Felis Concolor*, are yet with us; a straggler is occasionally seen. Benjamin Bones of Racine shot one on the head-waters of Black river, December, 1863.

Wolverines, *Gulo luscus*, are occasionally taken in the timber; one was taken in La Crosse county in 1870.

Of beaver, *Castor Canadensis*, a few still continue to inhabit some of the small lakes situated in Lincoln and adjacent counties.

The badger, *Taxidea Americana*, is now nearly extinct in Wisconsin. In a few years the only badger found in the state will be the one on the coat of arms.

The opossum, *Didelphis Virginiana*, were not uncommon in

Racine and Walworth counties as late as 1848. They have been caught as far north as Waukesha, and one near Madison in 1872, since which time I have not heard of any being taken. I am told that a few are still found in Grant county. They will soon be exterminated, no doubt. The last wild turkeys, *Meleagris Gallopavo*, in the eastern part of the state, was in the fall of 1846, at which time a few were discovered near Racine. They were hunted with such vigor that the entire number were shot, "The last of the Mohicans." I am told, by Dr. E. B. Wolcott, that turkeys were abundant in Wisconsin previous to the hard winter of 1842–3, when snow was yet two feet deep in March, with a firm crust, so that the turkeys could not get to the ground; they hence became so poor and weak that they could not fly and so were an easy prey for the wolves, wildcats, foxes and minks. The Doctor further stated that he saw but one single turkey the next winter, and none since. One was shot in Grant county in the fall of 1872. Possibly there are a few yet to be found in this large southwestern county; if not, then wild turkeys are exterminated in the state of Wisconsin.

OBSERVATIONS ON THE RECENT GLACIAL DRIFT OF THE ALPS.

By T. C. Chamberlin, A. M., Ph. D., State Geologist.

The drift formation of our state forms an important feature of its geology, and, owing to some peculiarities of its development, perhaps more than ordinary interest attaches to it. I therefore zealously embraced the opportunity which a visit to Switzerland afforded of observing the drift deposits formed by the glaciers of the Alps.

Observations were made upon the deposits of the Bossons, Bois or Mer de Glace, Findelin, Gorner, Viesch, Aletsch, Rhone, Unter Aar, and the upper and lower Grindewald glaciers, and, casually, as many more.

It was my endeavor to use the limited time at my command to as great an advantage as possible by confining my attention to those features which are most analogous to our drift; the more so, because it is most difficult to gather exact and definite descriptions of this phase of glacial phenomena from most accessible writings on the subject, and naturally enough so, because the glaciers themselves and their surface moraines present so much more conspicuous and absorbing objects of interest.

My observations will, therefore, have value, if they have value at all, not because of their fullness and completeness, for they do not approach to that, but because they were made from this standpoint, and because they have been brought to the standard of the same mental meter with our own deposits; and whether that meter be standard or otherwise, it is hoped that, with some corrections for mental temperature, it has measured alike in both cases.

It is essential, at the outset, to clearly discriminate between the products that arise under those conditions which are peculiar to Alpine situations and those that are more specifically due to glacial agency without regard to special local circumstances; and hence a few explanatory words, antecedent to the observations themselves, may be appropriate.

In the majority of cases, Alpine glaciers occupy narrow steep valleys which afford them little opportunity to deploy as they undoubtedly would in more open ground, where they might present phenomena analogous to those of continental or arctic glaciers; but in some cases, they terminate, or have recently done so, in broader and less sloping portions of their channels, and thus furnish some very valuable hints as to the probable action of broad glaciers on less sloping floors.

Alpine glaciers derive the material of their deposits from two general sources, and their debris is correspondingly divided into two general classes, 1st, that which falls upon them from above, and 2d, that which they abrade from the rocks over which, or against which they move. The first class is borne passively *on* the ice stream, while the second is pushed or rolled along *beneath* it. The first is due to the accident of the glacier's position, the second is the direct result of its own action. The first class is only present when the glacier originates among towering peaks or flows along precipitous slopes; the latter presumably is always present. At the edges of the glacier the two classes often mingle, and undoubtedly some of the surface debris finds its way to the bottom through crevasses and moulins, so that the material carried along beneath the glacier is greater than it would be but for the surface burden; but, for the purposes of our study, this is unimportant. It is imperative, however, that we distinguish between the superficial and basal debris, as the former can have little or no representative in so plane a region as that covered by our drift, and can therefore throw no light upon its origin. This distinction is very easily made, for the most part, in the case of the Alpine glaciers mentioned; for the surface material is almost wholly unworn and angular, while the basal portion is usually abraded and rounded in greater or less measure.

The surface material forms in lines along the sides of the ice stream, where it has fallen from above, constituting lateral moraines; and where two streams unite, two of these lateral moraines are brought together and form a line along the middle of the joint stream, constituting a medial moraine.

To the rock rubbish borne along beneath the glacier, the term ground moraine, or *moraine profonde*, is applied.

So far, all is clear. So long as the glacier itself is present bearing lateral moraines on its sides, medial moraines on its surface and a ground moraine at its base, there is no room for confusion. But this detrital material at length reaches the end of the glacier and is deposited; and here arises something of confusion in the deposit itself, and something of confusion of ideas respecting it, or at least, a want of accurate and precise use of terms. The phrase terminal moraine is used to designate accumulations formed at the extremity of the glacier. But, setting aside the terminal deposits arising from the dropping of the lateral moraines, which remain somewhat distinct, it is evident that the medial moraine will be dropped upon the ground moraine at the foot of the glacier, and that this will occur under three conditions that ought to be distinguished. First, the foot of the glacier may be retreating, as is the case at present, because the melting is more active than the onward flow of the ice. Under these circumstances, the withdrawal of the ice leaves the medial moraines as a ridge, or line of debris, lying on the sheet-like ground moraine, and their relations remain essentially the same as before, save that the glacier has vanished from between them. In this instance the terms medial and ground moraines may still be used appropriately to designate them.

Secondly, the foot of the glacier may be stationary, in which case the material of the ground moraine, pushed along beneath, will accumulate at the glacier's margin in the form of a ridge, and the medial moraines will pile up in heaps on this. To call this simply a terminal moraine is not to speak very discriminately; for, in addition to the complexity of its own formation, it is liable to be confused with that which arises under the third condition, viz.: that in which the foot of the glacier is advancing.

In this case the glacier is not only discharging material from its surface and bearing it along its base, but it is plowing up that previously deposited in its pathway.[1] The result of this is the formation of a ridge at the foot of the ice plow, as in the previous case, but of more irregular character in respect, at once, to material, structure, and surface configuration. This is a terminal

[1] A portion is also overridden by the glacier.

moraine in a more significant sense than the preceding, in that it was not simply accumulated at the foot of the glacier, but was formed by its mechanical agency; and in that it marks the termination of a given glacial advance.

It would appear to be much in the interest of precision of thought and expression to confine the phrase "terminal moraine" to accumulations produced by a glacial advance, and to employ some other term, as peripheral moraine, for ridge-like accumulations due to halts in the retreat of the glacier; while the term "ground moraine" should include the wide-spread, sheet-like deposits of retreating glaciers. Our classification of morainic accumulations would then stand:

I. SUPERFICIAL MORAINES.

(*a*) *Due to local environment and passive glacial agency.*

(*b*) *Characterized by angular material.*

1. Lateral moraines.
2. Medial moraines.

II. BASAL MORAINES.

(*a*) *Independent of local environment and due to active glacial agency.*

(*b*) *Characterized by worn material.*

1. Ground moraines (sheet-like).
2. Peripheral moraines.
3. Terminal moraines.

Besides the glacial accumulations, we have constantly to deal with the associated torrential and other aqueous deposits formed by the abundant glacial waters, but these may usually be distinguished by structural characters.

The following observations relate to individual features of drift phenomena, and will be found more or less disconnected, and the paragraphs are arranged without much reference to logical sequence of thought:

1. The Rhone glacier surpasses all others visited in its instructiveness in relation to drift deposits. After a course of nearly 15 miles, it descends precipitously, like a gigantic frozen cascade, into a valley of the Rhone, where it finds a broader area and

more gentle slope. Here its foot spreads out into a flat semicircular form not altogether unlike an equine hoof.

The first point of special interest to be noticed is that the crevasses in this flat portion diverge in curving lines from the axis of the glacier toward the expanded margin. This I believe to be correlated with a divergent motion of the ice by which the expanded foot was formed; and in this I find a close analogy to the divergent motion of the ice of our own ancient Green Bay glacier, as shown in my recent report. The valley of the Rhone just below this is covered with drift, so that the striations, which it might be presumed to have made in its recently more expanded condition, are concealed, but at the foot of the Glacier de Bois, in the Chamouni valley, a divergence in striation amounting to about 75° was observed.

2. The Rhone glacier is now retreating at a somewhat rapid rate. With commendable regard for the interests of science and the profit of transient students, the successive positions occupied by the retreating foot of the glacier, each year since 1874, have been marked by lines of tarred bowlders and cairns. The method and rate of retreat is thus mapped out on the face of the valley itself. It will be sufficiently near for our purposes to say that the average retreat since 1874, has been about fifty paces per year. It therefore presents a fine opportunity to observe the deposition of a receding glacier, and, as it bears but little detritus on its surface, its abandoned ground moraine is well exposed for study. However, certain portions of the plain have been swept by glacial floods, which have somewhat modified the deposit, and care should be taken not to confuse the two deposits. A little close observation will show that in the portions recently abandoned by the glacier, and that have not been washed by the issuing waters, the bowlders frequently bear, perched upon their tops and slopes, sand, pebbles, and small fragments of rock. It is hence evident that they have never been swept by even the gentlest stream, and that no assorting or modifying action of any kind has been brought to bear upon them since they were abandoned by the ice. Furthermore, we may go to the foot of the glacier and see them slowly issuing, thus crowned, directly from the ice.

The ground moraine here consists mainly of rounded and scratched bowlders, gravel and sand, with but little clay, and only a small proportion of angular blocks that cannot be traced distinctly to the medial or lateral moraines. The surface contour is slightly, though not conspicuously, ridged. The more abrupt side of these little ridges is toward the glacier and their trend is in the main approximately parallel to the edge of the glacier, though sometimes notably oblique. This relationship suggested that they might be due to annual oscillations of the glacial margin. There is also discernable a feeble tendency of the material to arrange itself in heaps and ridges parallel to the lines of movement of the ice.

3. If we now approach the foot of the glacier, we shall find this moranic sheet of detritus passing without notable change or interruption beneath the ice. The appearance is as though a stationary mass of ice had formed on the surface of a bed of bowlders and gravel and was now quietly melting away. More critical examination would, of course, show that any given particle of ice was advancing. The edge of the glacier is thin and sloping and we may walk directly up on it. The edge seems to rest lightly upon the drift below. This last is not a mass of debris frozen together, or imbedded in the base of the ice — although individual bowlders are — but an independent underlying bed of bowlders, and finer material and open interspaces. These observations of course relate to the immediate edge of the ice. Some of the crevasses enable us to see a short distance farther in, where the same condition prevails. An artificial tunnel, styled an ice grotto, shows the same through a break in the ice.

The marginal portion of the glacier rests, so far as could be ascertained, not upon the bed rock, but upon its own basal moraine. How thick this bottom accumulation was, I had no means of ascertaining, but from the configuration of the valley, I should judge it was considerable.

4. The surface contour of the ground moraine seems to some extent to take shape beneath the glacier. At one point I observed a diminutive hillock, about six feet high, half enclosed in the edge of the ice, which was here nearly vertical. The appearance was

as though the ice, in its withdrawal, had half disclosed a mound lying beneath it. This, though a mere mound, was about equal in height to the adjacent heaps that had been left by the glacier.

5. At other points, near the center of the valley, the ice may be seen resting directly upon well assorted, stratified sand and gravel. Level sheets of fine detrital matter extend without disturbance of continuity or surface beneath the edge of the glacier. The assortment and stratification of this material was apparently accomplished by sub-glacial streams, which seem afterwards to have found other avenues, when the ice occupied their place, either by settling down from above, or advancing from behind. The singular fact is that the stratified sands should not have been disturbed. It is very likely true that these fragile formations near the edge of the glacier are heated by conduction from the warm earth surrounding, and by transmission through the comparatively thin ice above, and that they are thus enabled to protect themselves from the forcible action of the ice, by melting it as fast as, in its slow motion. it is pressed upon them.

6. If we now turn to the sides of the valley, we shall see that up to a certain height they are mainly bare of vegetation and present a fresher and less weathered surface than the slopes above, as though the glacier had recently stood at that hight. If we glance down the valley, we shall see that the upper margin of this surface descends curvingly, much like the contour of the present foot of the glacier. If we descend the valley to the point where this reaches the plain, we shall find the ground moraine rising into a low, irregular ridge, which stretches in a broken curve across the valley. The material of this ridge is essentially the same as that of the ground moraine, save that there is noticeably more sand and gravel in proportion to the coarse material, and the whole is more thoroughly rounded. These remarks relate to the surface material. The superficial contour, however, assumes quite a different and distinctive aspect. Although but a diminutive ridge itself, not perhaps exceeding twenty feet in height, its surface contour, instead of presenting a simple curving outline, exhibits a complex series of still more diminutive ridges, hills and hummocks, of irregular outline and arrangement, accom-

panied by correspondingly irregular depressions, some of which are filled with water and form miniature lakelets. The irregular outline and little islands of one of these made it almost a Lilliputian Minnetonka. Bowlders are abundant in all positions on and in the ridge, as shown by the sections exposed by the outflowing streams, which also exhibit the confused unstratified condition of the interior. Locally, there are small patches of stratified material. This ridge is most abrupt on the outside, or that away from the glacier, while on the inside it graduates, without any distinct line of definition, into the bowlder sheet above described.

This ridge presents a striking similitude to our Wisconsin Kettle moraine, and I think it may be safely said to be a miniature representative of the same phenomena.

This is a true terminal moraine, according to our definition, formed by an advance of the Rhone glacier.

7. A few rods — perhaps 20 — below this there is another moraine of like character, but of older date, as shown by the grass and shrubs that have grown upon it, as well as by its position and less angular contour. It is narrower and more simple in form than the preceding, and like it, is interrupted by level passes, the channels of former streams.

About 30 rods below this is a third, still less continuous, a good illustration of an interrupted, half destroyed moraine.

8. Between these three moraines are level gravel flats of fluviatile origin, and doubtless stratified.

9. On the south side of the Rhone, the middle moraine breaks up into an area of scattered mounds or "knobby drift."

10. On that side also, at the foot of the acclivity, where the solar action is less effective than elsewhere, a considerable mass of ice has been left by the retreating glacier, and this is much covered by sand, gravel and coarse detrital matter. As the ice melts, it deposits its burden of rock-rubbish in an irregular, hummocky fashion, somewhat resembling that of the moraine above described, but without the ridgey characteristics of the latter. It is mainly interesting as illustrating the form of deposition of a superficial glacial accumulation where the ice lets it down by melt-

ing from beneath, instead of casting it over its extremity in the usual method.

11. The south side of the Rhone also presents a fine exhibit of fluviatile silt, sand and gravel flats, and shows the pre-eminent tendency of glacial streams to wander widely, back and forth, across their valleys, when the slope is moderate, owing to the unusual rapidity with which they fill up their channels by the large burden of glacial mud, sand and gravel that they carry, or roll along their beds. They thus rapidly accumulate broad stratified sheets. I suspect that some deposits formed in this way during the Quaternary age have been mistaken for lacustrine formations, owing to their breadth and extent.

12. None of the other glaciers visited terminate in a manner equally favorable to the observations sought, but some of them present particular features of equal interest. The terminal moraines of the Grindenwald glaciers are even more instructive by way of comparison with our drift moraines, because of the closer proximity of the successive ridges, and greater similarity of the material, it being a limestone bowlder clay, with some metamorphic erratics included, and some assorted detritus. Some of the moraine ridges are a pronounced bowlder clay, while others are largely composed of bowlders or gravel. On the inner moraine of the upper Grindenwald glacier, there is much fine gravel and sand in heaps and miniature ridges, presenting a very interesting phenomenon. The outer range is more massive than those of the Rhone glacier, and is very strikingly similar to the Wisconsin Kettle moraine in its superficial expression. The corresponding moraines of the lower Grindelwald glacier show the same features very neatly, and those of the Bois and other glaciers display like characteristics.

13. So far as my observations went, the nature of the rock over which the glaciers passed was more influential in determining the proportion of clay, sand, gravel and bowlders, than I had supposed. Where the rock was mainly granitic, the amount of clay was proportionately small, the detritus being mainly coarse sand, gravel and bowlders. This was doubtless due to the difficulty of reducing the hard constituents of granite to powder. Where the

glacial channel lay through schistose rocks, or limestone, there was a notable larger proportion of clay, and some of the moraines were a typical bowlder clay. These observations throw unexpected light on the drift of our state, where there is a very marked difference between the glacial deposits of the limestone and granitic districts in respect to the physical condition of the material.

14. In former times, the Alpine glaciers were greatly expanded and stretched entirely across the lake region to the foot of the Jura mountains, on the French border. In this expanded condition, they most nearly, though still quite inadequately, represent the nature of American Quaternary glaciers. The Juras and much of the intermediate region are composed of limestone strata. To the west of Lake Neuchatel the sheet of drift extends up the mountain slope nearly 3,000 feet above the lake surface, when it terminates on the declivity in a rude, imperfect terrace of undulatory surface. This, where I observed it, is composed of bowlder clay, usually quite gravelly, and associated with gravel beds. It was my hope to find the margin of this great *moraine profonde* at some point on a comparatively level tract, where its development would not be cramped or coerced by encompassing barriers, but both at this point and in the vicinity of Gex, west of Geneva — the only two points where I was able to examine it — I found it pushed high up on the steep side of the mountains, and could, therefore, only conjecture what its form and structure would have been on plains similar to those of the Mississippi valley; indeed we can hardly assume that its material would have remained precisely the same, since in more level regions it might have been influenced in a greater degree by glacial waters. As it was, it may be characterized as a gravelly bowlder clay, with accompanying gravel beds.

15. In the beautiful valley of Ruz, west of Neuchatel, I found excellent exhibits of the morainic bowlder clay. If an excavation seen on the east side of this valley were placed side by side with any one of a large number that can be found in Wisconsin, no one but a skilled lithologist or paleontologist could determine to which locality they severally belonged, so striking is the physical similarity of the two formations. Indeed the resemblance of

the rock forming the detrital material is so close that, were the Swiss hill transplanted to certain localities in Eastern Wisconsin, probably no geologist would ever detect the imposition, unless fossils, of which I saw none, were found in it.

16. In company with our genial vice consul at Geneva, Dr. Delavan, I had the pleasure of visiting the celebrated Jardin, in the Chamouni region. A four hours walk up the *Mer de Glace* and over the *Glacier de Talèfre* brought us to an island of sub-triangular outline, completely encompassed by a sheet of snow and ice; and around which clustered an amphitheater of mountain pinnacles. It derives its name, "The Garden," from the fact that, although more than nine thousand feet above the sea, and surrounded on all sides by perpetual snow and ice, a handsome flora of grasses and bright, beautiful, little flowers bloom on its southward sloping side. But, putting aside this interesting phenomenon, and restraining the sentiments, which the magnificent surroundings and the grand views of Mount Blanc and the glaciers below inspire, I can only, in this connection, remark upon the point of chief geological interest to us, viz.: the likeness to our driftless area which this glacier-girt island presents. Let me say, however, at the outset, that the Jardin is not a driftless area. It was formerly covered by an ice sheet and contains erratics on its surface. But at present, though the glacier originates much higher up the slope, it divides and passes around the Jardin and again unites below it, leaving it, so far as present action is concerned, a non-glaciated area, surrounded on all sides by active glaciation.

Its likeness to our driftless area, however, ceases here. It is walled in, as is appropriate to a garden, by a steep sharp moraine, thrust up by the ice in moving around it. On the border of our driftless area, the glacial debris thins out very gradually and disappears in an obscure margin. The Jardin differs also, in that it appears to owe its immunity from present glacial action more to its own prominence than to the effects of adjacent depressions. The driftless area of Wisconsin does not lie, like it, on the summit of a protuberance, but on its lee side. The ice of the glacial period surmounted the Archæan heights, south of Lake Superior, in Wisconsin and Michigan, and descended the southern slope a

distance of about one hundred miles, where it terminated on the declivity, and its waters continued on across the driftless area, leaving gravel terraces along their course. We must, therefore, seek elsewhere for an adequate illustration of the essential principles involved.

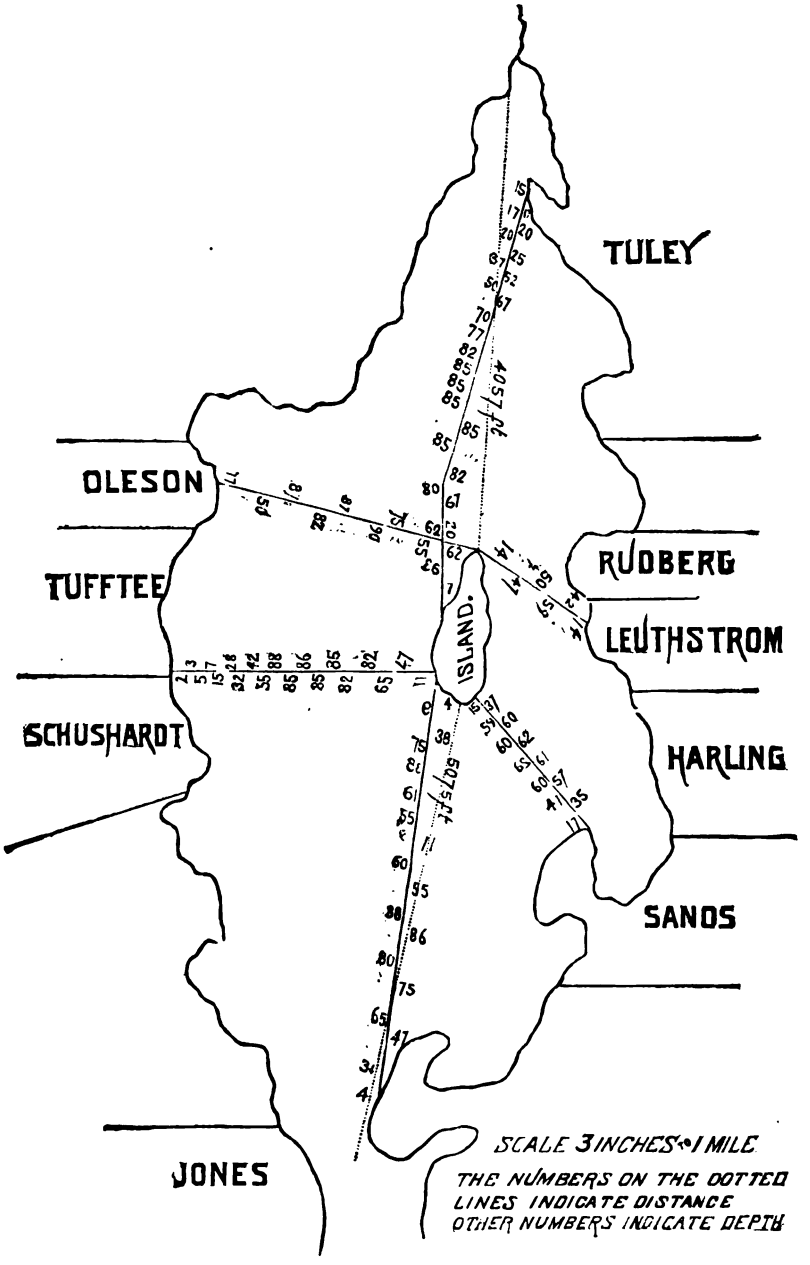
At the foot of the Viesch glacier, the ice stream divides and the branches pass through valleys on either side of a ridge, though the ice at the point of branching is higher than the ridge. Formerly the branches extended much further, and probably united below the ridge. This would be an approach to an illustration of the phenomena in question, but, unless the ice moved over the ridge, and terminated on its slope, it would fail of an essential element.

The right hand branch of this glacier is antagonized by a prominence, and the greater portion of the ice passes through lower channels on either hand; and these subordinate streams approach each other below, leaving an island, or nearly so, on the slope. Above this island the ice terminates on the declivity. On one side the slope is so steep that the ice breaks away and rolls to the bottom, marring the perfection of the illustration, but not destroying its force. The ice, while not really split in twain, is so far thinned by the combined action of the prominence and the adjacent depressions, as to be unable to maintain itself against the wasting to which it is subjected. If the slope were somewhat less precipitous the illustration would be more complete.

Near the termination of the upper Grindenwald glacier, there has recently been a similar instance of an island in a glacial stream with higher ice on either side and above it. In this case, the slope was so great that a portion of the ice above the island became loosened and rolled down to the ice below. The amount which thus passed over was less than an equivalent of the melting capacity of the area of the island, so that, had not the cohesion of the ice been overcome, it would have been melted on the upper margin of the island.

In all the foregoing instances, the areas have formerly been glaciated, and thus differ from the Wisconsin driftless area. They have force, however, as illustrating, in a miniature and imperfect

fashion, the fact that, not only may a glacial stream be parted and an island be formed by a prominence projecting through the ice and wedging it aside, or by valleys leading it around; but also that there may be such a combination of prominence and depression as — while not entirely parting the stream — to so thin the ice passing over the prominence, that it shall be wasted and disappear before it can join the main currents diverted on either side; so that there shall be a non-glaciated area, not on the summit of the prominence, but on its lower slope, and these I conceive to be the essential phenomena and elucidation of the Wisconsin driftless area.



PINE LAKE

WAUKESHA Co
WIS.

TEMPERATURE OF PINE, BEAVER AND OKANCHEE LAKES, WAUKESHA COUNTY, WISCONSIN, AT DIFFERENT DEPTHS, EXTENDING FROM MAY TO DECEMBER, 1879; ALSO PARTICULARS OF DEPTHS OF PINE LAKE.

By Elizabeth M. Gifford and Geo. W. Peckham.

Pine lake is two miles long, with an average width of three-quarters of one mile. Its mean depth, perhaps, being greater than that of any other lake in the county. The most interesting fact resulting from the observations is the regular decrease of temperature with increase of depth down to eighty-five feet. At this depth, from May to November, the mercury was constant at 42° Fahrenheit. In the observations on the temperature of Oconomowoc lake by the late Dr. Lapham — Transactions, Vol. III, p. 31 — he states, "that an attempt was made to find the temperature at the bottom in deep water, and resulted in showing at some times no differences, and at other times one or two degrees warmer or cooler; though the deep water is popularly believed to be much colder than that at the surface." It is probable that his observations were not made with a self-registering thermometer, and in drawing up a common thermometer from any considerable depth, it would take on the temperature near the surface. As a result of a number of experiments we found this supposition to be correct. Our observations show a difference of 14° Fahrenheit, in surface and bottom temperature, until the middle of October. Prof. Nichols found that the temperature in Forest Pond, Cambridge, Mass., was nearly uniform from top to bottom about the first of November. We found a uniform temperature December 2d. Probably in a larger lake this condition would not be reached before January. For valuable data on the temperature of Massachusetts waters, see papers by Prof. W. R. Nichols, in the Massachusetts State Board of Health Reports.

PINE LAKE, WAUKESHA COUNTY, WISCONSIN.

These observations were made with the self-registering thermometer, Fahrenheit scale, manufactured by Hicks, of London; checked in same cases by Green's U. S. Signal Service thermometer.

Date.	Time of Day.		Temperature of air.	Temperature of Water.								
	A. M.	P. M.		Surface.	Ten feet.	Twenty feet.	Thirty feet.	Forty feet.	Fifty feet.	Sixty feet.	Seventy feet.	Eighty feet.
1879.			°	°	°	°	°	°	°	°	°	°
May 11	9	.....	68	55	....	....	....	....	....	....	....	41
May 15	....	2	68	55	....	....	....	....	....	....	....	41
May 27	....	3	64	60	....	....	....	....	....	....	....	42
June 2	....	6:30	60	62	....	....	....	....	....	....	....	42
June 7	...	7	60	62	....	....	....	....	....	....	....	42
June 11	....	7	72	67	....	....	....	....	....	....	....	42
July 12	....	7	79	79	...	75	60	49	46	44	43	42
July 14	....	4	77	79	71	65	56	50	49	....	....	...
August 11	...	3	82	76	76	75	68	49	46	45	....	...
August 31	10	7	77	75	...	73	....	50	....	....	....	...
August 31	....	3	79	75	...	....	....	50[1]	....	....	....	...
September 1	11	.....	77	74	...	....	....	50[2]	....	....	44	...
September 9	10	.....	60	62	....	....	....	....	....	44[3]	44	...
September 16	...	5	59	62	....	....	....	....	....	....	44	[4]41
September 29	....	3	60	58	....	....	....	....	....	....	...	42
October 5	...	5	76	62	....	61	59	55[5]	54	43	....	42
October 12	9	.....	69	59	....	....	....	59	49[6]	45	....	...
November 1	....	4	40	49	....	....	....	39	....	....	....	34
November 5	....	4	42	48	....	....	....	....	....	....	....	...
December 2	....	2	40	40	....	....	....	....	....	....	....	39

[1] Average of ten observations.
[2] Average of five observations.
[3] Average of five observations.
[4] Two observations.
[5] Two observations.
[6] Two observations.

BEAVER LAKE, WAUKESHA CO., WISCONSIN.

Date.	Time of Day.		Temperature of air.	Temperature of Water.									
	A. M.	P. M.		Surface.	Five feet.	Ten feet.	Twenty feet.	Twenty-seven feet.	Thirty feet.	Forty feet.	Forty-five feet.	Fifty feet.	Seventy-five ft.
1879.			°	°	°	°	°	°	°	°	°	°	°
May 19	.....	4:00	75	63	....	....	....	....	....	....	....	....	....
May 24	.....	4:30	78	63	....	....	....	57	50	....	....	....	....
July 13	.....	4:00	77	79	....	....	65	....	50	49	....	....	....

OKANCHEE LAKE, WAUKESHA COUNTY, WISCONSIN.

July 14	6:45	.....	79	80	80	80	[1] 76	....	64	49	....	46	44

[1] Two observations.

A DESCRIPTION OF SOME FOSSIL TRACKS FROM THE POTSDAM SANDSTONE.

By Prof. James E. Todd.[1]

[1] At the winter meeting of the Academy in 1879, a verbal description and discussion of these tracks, illustrated by photographs, was presented by Prof. T. C. Chamberlin, but the pressure of other work preventing the preparation of a description for the press, the matter was placed in the hands of the writer. The names here adopted are those then proposed. The specimens on which the descriptions are based — in all about half a ton of slabs — are in the cabinet of Beloit College, and were procured through the kindness of Mr. Young and at the expense of Mr. Chamberlin.

Several months since, Rev. A. A. Young of New Lisbon, Wis., called the attention of the state geologist to some very interesting fossil tracks, that occur at two quarries located near the Lemonweir river. They are about four miles north of the village of New Lisbon. The geological horizon is the upper portion of the Potsdam. The rock upon which they are impressed is a medium-grained, compact, hard, silicious sandstone, which splits readily into flags, three or four inches in thickness. The conditions of its deposition are indicated by distinct, and often oblique lamination, and by ripple marks. No animal remains have yet been found associated with the tracks, though these are remarkably well preserved.

1. The general appearance of the tracks is of broad serpentine bands crossing the stone, and sometimes so thickly as to obscure one another, and give the appearance of an irregularly rippled surface.

The margins of the tracks appear to have been originally unbroken lines, and parallel. The whole surface between these lines has evidently been in contact with the animal making the track, and there are no signs that any part of the animal reached beyond these lines.

2. The most conspicuous element of the track consists of a closely consecutive series of nearly parallel, transverse ridges,

which, moreover, are not usually straight and exactly transverse, but most frequently V-shaped with the apex of the V pointing forward. This form, though the prevailing one, is nevertheless subject to the following modifications: The angle varies in the

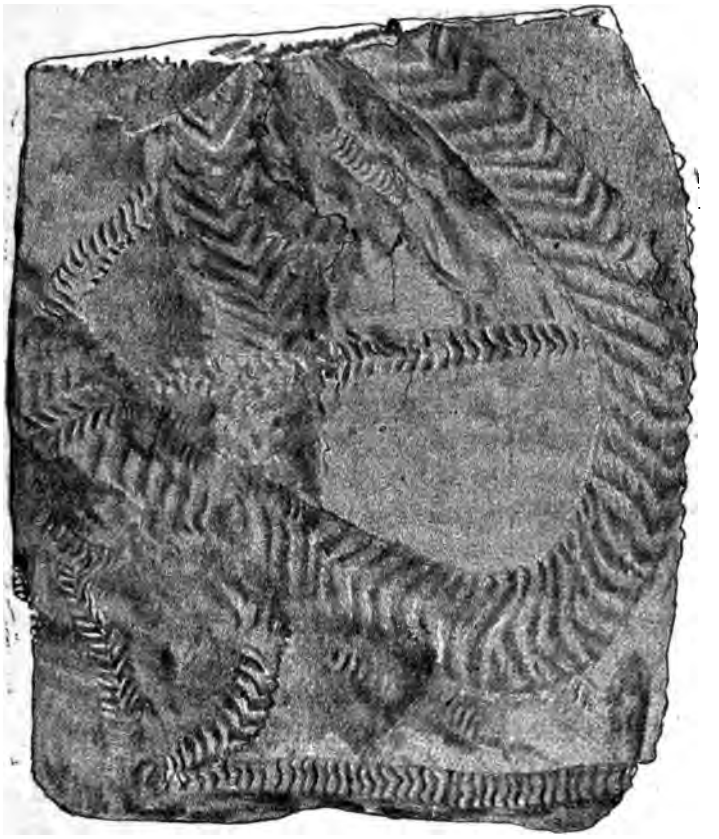


PLATE 1—FOSSIL TRACKS ON POTSDAM SANDSTONE.
(From photograph.)

typical cases from the extreme limit of 110° to 135°. When the V becomes distorted, this angle appears to vary further, through larger angles, till, in various cases, it disappears, and the ridges are straight. This occurs somewhat more commonly in the smaller tracks.

Another frequent variation is in the relative length of the arms of the V, and the consequent shifting of the point towards one

side of the track. When the V remains at all regular this is toward the convex margin when the track is curved (*vid.* plate 1).

The surfaces of the ripple-like ridges are usually regularly convex, and this convexity is so nearly equal to the concavity of the furrows between, that from this feature alone, it would be impossible to say whether, in a particular case, you were looking upon the track itself, or upon the cast of it, found on the upper slab. Not infrequently the ridge is narrower than the furrow. Sometimes the converse is true. If either slope of the ridge is more inclined than the other, it is usually the posterior one, unless it has been modified by longitudinal lines, when the converse may be true. With this character may be connected the fact that from the way in which the stone breaks in the ridges, there is additional evidence that the ridges in their formation were pressed and moved backward somewhat.

Not infrequently the arms of the V are not formed together; sometimes they alternate for a time, sometimes an extra arm is intercalated between two V's, which are distorted, to adapt themselves to the case. Such cases occur more frequently in curves, but are not confined to them.

Sometimes the V-form of the ridge changes to a wavy line, a low W, a regular curve, or a straight line, and that within a short space, in the same track.

Sometimes the transverse ridges appear to fade out, as if the consistency was insufficient to sustain them after they were formed.

3. The third element of the tracks are the longitudinal lines. These are seen frequently modifying the tops of the ridges, and forming the most reliable guide, in determining which impressions are the tracks, and which the casts; also, in which direction the animal moved. The track may also be sometimes distinguished from its cast, by its transverse section being a little concave or depressed.

These markings may be divided into three kinds.

First, those quite closely parallel with the sides of the track, as though formed by some appendages dragged over the ridges after they were formed. Of these, some seem to be made by rigid,

posterior points, or by the lateral edges on some kind of a caudal shield. This appears in pl. 1, toward the left above, and in unfigured examples. The most common ones appear as if formed by flexible bristles dragged over the track. They are sometimes wavy, as though the appendages swayed from side to side.

The third kind of markings is best seen near the sides of the curves, and then only in rare instances. These cross the transverse ridges more nearly at right angles and appear to have been formed by bristles of some kind attached to whatever formed the ridges.

As to the dimensions of the tracks, it may be said that they vary greatly, though all may be grouped in three sizes. The largest are 4–4½ inches wide, with a distance of 1⅛–1¼ inches between the transverse ridges, when of the normal form. When there is a curve, the ridges may be much closer towards the inner side of the curve and more distant on the outer side. This size includes the most conspicuous tracks on pl. 1, where one presents a curved course over five feet in length; also upon pl. 2 and pl. 3, 1 below, and 2. The three kinds of finer markings are found only in tracks of this size. The next size is 2–2½ inches across, about ½ inch between the ridges, and the smallest size is from 1¼ to 1¾ inches in width. All of both these sizes show the cross ridges with the V more or less clearly marked, intercalations, and the usual convex surfaces, with perhaps one exception, which is seen at the bottom of pl. 1. In this one the ridges are flattened with a slight dip forward. This may be formed by a distinct species; while the others may be conceived as formed by different stages of the same species.

These tracks closely resemble some described by Sir W. E. Logan, from Perth, Canada, and named by him, *Climactichnites Wilsoni* (*vid.* Geological Survey of Canada, 1863, p. 107). A figure presenting more of the details, is found in Dana's Manual, p. 176. They have been ascribed by different geologists to Molluscs, Worms, and Trilobites. These under consideration differ from the Canada tracks, however, in lacking the marginal ridges in all cases, except one very equivocal one. So far as we are aware, they are also without the finer longitudinal markings.

It is possible, however, that the difference is owing mainly, if not entirely, to a difference of the medium in which they were found. These Wisconsin tracks, as before implied, were formed in loose sand, composed of rounded grains. Similar animals, moving upon mud, would probably push up, on either side of the track, a ridge of sufficient consistency to stand. We are not informed as to the character of the rock in which the Canada tracks are found.

For convenience for future reference, the larger tracks described, showing occasional longitudinal and wavy markings, we would provisionally name *Climactichnites Youngi;* and under this would include all the smaller ones, showing regular convex and V-shaped transverse ridges. They may prove to have been formed by immature individuals. The solitary track, pl. 1, below, with flat and usually straight ridges, may be a variety of the same; but these differences, with others not easily expressed, seem sufficient reason for designating it by another name, viz.— *Climactichnites Fosteri.* It should be distinctly understood that the names may be discontinued, whenever the name of the species of animals which formed them can be definitely and satisfactorily substituted.

This paper would doubtless be considered incomplete, did it not give at least some conjecture concerning the character of the animals which formed these tracks. (We say animals, for the suggestion of Prof. Chapman, of Toronto, that *Climactichnites* are impressions of Fucoids (*vid.* American Journal of Science, vol. 14, p. 240), clearly cannot apply to these under consideration. The longitudinal lines and variations of the transverse ridges, appearing with such irregularity, forbid the idea.)

Endeavoring to confine ourselves strictly to the facts, and the most patent inferences therefrom, we conclude that, whatever the nature of the animals and whatever the form of their anterior ambulatory organs, those leaving the last impressions were very perfectly flexible. This is shown in the very variable form of the transverse ridges, as noted above.

They must have been in pairs, and each capable of motion, independent of its fellow. This is proved by the intercalated ridges.

Each separate organ seems usually to have been moved backward, and inward, in that way forming the V-shaped ridges.

The deepness and smoothness of the impressions may be partly the result of similar movements of successive organs, pressing into the same furrow. The longitudinal lines may have been easily made, it would seem, by a rigid candal shield, furnished, in some cases, with bristles, or slender spines.

The finer traces, nearly transverse to the ridges, may have been produced either by the "recover of the paddles, or by the flowing of the mud," caused by their motion, or the onward movement of the animal. The latter supposition is strengthened, by their appearing only in places, where, from the lowness of the transverse ridges, and apparent washing of material into the depressions, the sand appears to have been of very slight consistency. On this supposition, the long curved track in pl. 1 passes at its sharpest turn, over a firmer spot, but elsewhere the bottom seems to have been much softer. So also in plate 3, 1 below, the track seems have been formed across a series of low ripple-ridges. After all, we must frankly admit, that of thelength, the weight, and the morphological structure of those ancient animals, we learn nothing decisive; and that with a scientific use of the imagination we get little more than a glimpse of the posterior part of their ventral surface.

A CHAPTER ON FOUNDATIONS.

By J. Nader, Civ. Eng., Madison, Wis.

The subject of this paper is perhaps one of the most difficult and uncertain problems which comes within the province of the Civil Engineer.

In treating on the subject of foundations, I will endeavor to review the whole practical series, from the ordinary foundation daily required and constructed, to such as tax the ingenuity of man and call forth the efforts of the highest quality of genius and talent.

The earth's surface, consists of all grades of solidity from the rock, to inpalpable mud; for this reason we have to be governed by circumstances, and where nature fails us we must supply the want by artifice.

1st. Beginning with the most stable, the rock, it is only necessary to prepare the surface so that it may receive the intended structure and all requirements are satisfied. Cases may, however occur where the rock bed is of such nature that it will disintegrate by the action of the elements, in all such it is simply necessary to excavate beyond the influence and replace the excavation with enduring material. Where the rock is of sufficient strength, the superstructure may receive considerable strength against lateral motion, as in the case of Eddystone and Bell rock lights, England, also Minot's ledge light and others in this country, by bolting the structure securely to the bed rock.

2d. Next to solid rock is a bed of hard gravel; this will in nearly all cases resist any amount of pressure that can be brought to bear, provided that in cold climates, the substantial work is carried to a depth beyond the influence of the frost.

3d. I shall presume to place sand next in order, to gravel, for solidity. In sand, it is only necessary to go beyond the frost line and to guard against lateral motion; in every other respect it will support weight equal to rock itself.

4th. Next to sand, impervious clay may be in order of resistance to pressure. This is a very common earth which yields only to the pick, is not plastic and does not become so from effects of moisture. A solid rock is scarcely more reliable against pressure than this clay.

5th. We now come to the less resisting soils among which the first are the plastic clays. These earths give good resistance when dry but undergo a soaking process from the effects of moisture and becoming plastic they yield to a considerable degree and many fine buildings have unaccountably failed a few years after their erection, while the fact was, that their very presence conducted the moisture to the bed of their foundations and became the means of their own destruction.

6th. And last brings us to the treacherous yielding alluvial beds among which the engineer is obliged to flounder with uncertainty in seeking a solution of the problem of stability.

Having touched upon the various earths and soils which come into practice, the problem is, how to construct with safety and economy under varying circumstances.

As before remarked, with a rock bed it is only necessary to prepare the bed to receive the desired structure.

With the second class, i. e., gravel bed, it is necessary to extend the base beyond the thickness of the wall to guard against lateral motion; as a rule an increase of about one-half the thickness of the wall will give a sufficient base. In some ordinary foundations in gravel, trenches are dug to the desired depth and filled with irregular fragments of stone and then grouted with thin mortar of lime or cement, in many cases the dry stone foundation alone is relied upon. The foundation of Fort Hamilton, New York Harbor, a granite battery of two tier of guns, is built of dry stone. The Fort has stood about fifty years with no sign of failure. The ground is gravel and hard clay. In case of bridge piers or abutments it is of course necessary to protect the bed from erosion by the force of ice gorges or freshets. This portion of the subject will be treated further on.

In the case of sand for foundations, I have presumed to place the same next in order to gravel. As before stated, sand is equal

to rock if lateral motion is prevented. There is, however, one precaution necessary, and this is, that the thickness of the bed of sand and the substratum should be examined and very carefully, as many cases have occurred in which the superstrata of sand was not of sufficient thickness to give reliable resistance. In such cases, as in the fifth class, resort to artificial support must be had as will be noticed as I progress.

In the 4th class there is no particular precaution necessary as it is presupposed, as already stated, that the bed will give sufficient resistance.

In considering the sixth class we arrive at that portion of our work where we may expect to meet the unusual difficulties, where science is often at fault, and where extensive practical knowledge is necessary to overcome the difficulty. It would perhaps be a loss of time for me to go over the ordinary methods of constructing foundations in what are considered substantial beds, excepting where I may have occasion to touch upon foundations for particular structures, my purpose is to review the best methods of overcoming the greatest difficulties.

General Delafield, ex-Chief of the U. S. Engineer Corps, has written a work upon foundations in yielding soil, in which he gives conclusive proofs of failure, in every case, of grillage or platform foundations. These foundations are made by excavating to a sufficient depth and placing two or more courses of strong timbers at right angles over the ground to be occupied; the spaces between the timber are then filled with bèton composed of cement, sand and broken stone or gravel. Over this is placed one or more courses of strong plank placed in close position and securely fastened to the grillage, and the structure is erected upon the floor thus resulting.

As before stated, these foundations have failed in every instance where extensive permanent buildings have been erected upon the same, and it was the opinion of General Delafield that the same should not be used unless in connection with some more reliable supports.

The platform foundation being a failure, our next resort is piling, and the different manners in which this may be applied, is one of the particular points I wish to touch upon in this paper.

Major Sanders of the Engineer Corps and Mr. McAlpin, Civ. Engr., have had perhaps the best opportunities of investigating this class of foundations and supplying reliable practical formulæ. Major Sanders has experimented and successfully constructed at Fort Delaware and Reedy Island on the Delaware river, on the most treacherous alluvium, upon which a permanent extensive building has perhaps ever been erected. Borings were made at these places to a depth of about 50 feet and nothing but a liquid impalpable sea of mud was found. Piles were driven from forty to ninety feet deep with the greatest ease. Trial piles were driven and loaded with great weights and the effect of these weights was observed and recorded during a series of years; from these observations a formula was deduced which became a basis of the construction of the foundation of Fort Delaware and similar structures.

Mr. McAlpin, eminent in his profession, had charge of the construction of the United States dry dock in the Brooklyn navy yard, and had to contend with a treacherous bed of quick sand and springs, where the difficulties encountered are almost indescribable and the engineers were at times almost driven to despair.

The results of the labors of the aforementioned engineers were almost identical and the application of their formulae, will, in doubtful cases, be liable to err on the side of safety.

At Fort Delaware, the possibility of reaching a bottom support for piling was out of the question, on account of the expense. The alternative was to consolidate and compact the super strata in such a manner as to support the weight of the design by driving as many piles as the ground would admit of; the piling was substantially capped, the spaces filled with bèton and covered with a strong timber floor, upon which the Fort now stands, without any failure. Had there been a hard substratum at a reasonable depth, the piles would in that case be only so many columns supporting the superstructure.

Major Sanders' formula is as follows:

Divide the fall of the ram in inches by the motion of the pile at the last blow in inches; multiply the quotient by one-eighth of

the weight of the ram in pounds, the product will be the weight the pile can bear with safety.

$$\left(W=\frac{R\times(h+z)}{8}\right)$$

Mithel's screw piles have been used with good success; they consist of iron piles in sections of desirable length, the bottom section having one turn of a broad iron screw; these are forced into the ground by turning them around by means of levers moved by man or horse power. The government of Great Britain has built a number of bridges in India upon screw pile piers, which have all been successful.

The screw cylinder I consider a great improvement over the screw pile. The cylinder is made of cast iron of convenient lengths; the lower section is provided with a screw on the outside, of a foot or more in width, the sections are screwed and bolted together by flanges on the inside; the earth is removed from the inside by suitable implements as fast as the cylinder progresses. The cylinder is afterwards filled with concrete.

The Triger system of foundations (so named from its inventor) and largely improved and applied by Mr. Hughes in England, is in reality an enlared hollow pile, and ultimately led to the use of very large cylinders and caissons. I present herewith a plan of an iron centre-pier for a swing bridge, the process of the operation of lowering, excavating, under pinning and filling is shown in the drawings. The centre pier of the iron swing bridge over the Harlem river at New York was constructed in this manner by Mr. McAlpin. There was one central and nine circumscribing cylinders of six feet diameter, these were put down from 60 to 80 feet until the bottom was considered sufficiently resisting to bear the great weight. When the cylinders came to rest, the base was enlarged four feet in all directions, this increased the resisting area to forty-nine as against nine without this precaution.

If there is much trouble from leakwater, the Plenum and Vacuum process may be applied by putting an airlock on the top of the cylinder and forcing in air under sufficient pressure to expel the water. When the excavation has proceeded as far as possible, the process is reversed and the air exhausted, the atmospheric pressure will then force the cylinder onward.

At the building of Skilligalee Light House, a great deal of difficulty was encountered. The shoal upon which the light is situated is in the northern end of Lake Michigan some miles from the east shore and is composed of gravel and boulders. As it was impossible to drive piles and the mass so irregular in consistence other means had to be employed in order to get a safe foundation.

The area was first enclosed by a secure cribdam, inside of this an iron cylinder sufficiently large to enclose the foundation of the tower was placed, open at top and bottom. It was supposed at first that the water could be kept down by means of pumps and the excavation be made it the open cylinder. It soon appeared that this was impossible; sheet piling was out of the question, and no matter how tight the cribdam might be made, the leaks through the boulders and gravel from below would still remain.

A diaphragm was constructed in the cylinder and the excavation continued under the plenum process until the cylinder reached about 13 feet below the lake water level.

Stone and other materials were passed through an air lock to the workmen below, and the lower part of the cylinder was built up with solid masonry until there was sufficient weight to exclude the water; the diaphragm was then cut away and the work continued from above. The unavoidable manner of operating brought the work into what we know at present "caisson," an exceedingly expensive and tedious plan, and, as in the case above mentioned, should only be a last resort when no other plan will promise success.

The latest wonders in construction are now before us. One the great steel arch bridge so successfully completed across the Mississippi at St. Louis, and the other now in process of construction across the East river at New York. In the case of the St. Louis bridge, the certainty of reaching bed rock was a great inducement to the engineer to adopt the caisson and place his work thereon, although a stratum of good earth was found under the river drift, which continued the same to the bottom. Had it been impossible to reach rock, a coffer-dam enclosure would have enabled the excavation to be made and bearing piles to be driven and would, in my estimation, have made a foundation as safe as the present one.

The Brooklyn caisson of the East river bridge rests for the most part on a bed of boulders and hard-pan at a depth of 44½ feet below mean high tide and the top of the caisson at 20 feet.

The depth of water is from 12 to 16 feet in front of the tower; the river drift was perhaps 12 to 14 feet deep. This leaves us but 30 feet from mean high tide to a good foundation, if properly treated.

This Brooklyn caisson cost something over $300,000; a coffer-dam would have cost less than $100,000; the excavation would have cost less also than the masonry; so that it is very evident that there would have been a considerable saving in cost. The weight resting upon the bottom is about 5½ tons per square foot, and is considered entirely safe. The settling at the water line has upon close observation barely exceeded one inch at any point.

The consideration of these two extraordinary structures has brought us to the subject of foundations in water. Many of the plans mentioned in a preceding part of this paper are applicable to piers and abutments in water. The solid and hollow screw pile and iron cylinder can be applied with success. A very common plan for piers consists of a sufficient number of bearing piles surrounded by timber cribs and the space filled with loose stone to support the piles against lateral motion. The crib is not permitted to rest upon the bottom but is supported some distance above so that the stone may roll out and assume a position which will give a broad base to the filling.

A very excellent plan for building piers and permanent wharves has been extensively applied by the U. S. Eng. Corps, where the bottom was of substantial material: A scaffold is erected upon piles driven by a floating pile driver, upon this the exact location of each pier is determined. Loose stone or bowlders are removed from the site and a sufficient number of bearing piles are driven and sawed off perfectly level close to the bottom. See plan of saw. The bottom course of the pier of 4, 6 or 8 feet square and 2 feet or over in thickness is composed of one stone, this stone is lewised at the corners and supported by chains to which are attached large screws which pass through timbers on the staging. The first stone being placed in the slings it is lowered to the level

of the staging. The second course composed of two or more stone is then built upon the first and set in mortar and clamped and doweled together. The screws are then slacked down until the top of the course is level with the staging, and so continue until the work reaches bottom. The several piers are then connected by iron beams and brick arches covered with concrete, the surface may be paved with any suitable material. I can state from my own experience that such piers have been built in from 12 to 20 feet of water without the least difficulty.

Gen'l Richard Delafield's memoir on foundations in compressible soils is probably the ablest investigation on the subject.

PRIMITIVE ARCHITECTURE IN AMERICA.

The Different Stages and Modes of Life Exhibited in the Pre-historic Works of America.

By Rev. S. D. Peet, Editor American Antiquarian.

One of the most noticeable things in the prehistoric works of America is that they present native architecture in various stages of development. The study of these works furnishes a clue to the states of society in pre-historic times. It also affords us many hints as to the pre-historic races, and their origin, growth and development. There is need, however, that we have a better understanding of these stages themselves. Now we propose to study the pre-historic works of America, so that, if possible, we can trace the line of development of society, or if not, so that we can discover various grades which have been presented by it. One of the difficulties in tracing a connected development is that these works are so separated from one another by geographical lines, that we cannot ascribe them to the same people. This is favorable in one respect, because the lines which separate the grades are distinct, and we can thus determine the characteristics which belong to each. There are all the differences between the pre-historic works found on this continent that have been supposed to exist in the works which have been so faithfully studied in the European countries. But the differences here are marked by peculiarities of architecture, rather than those of art; the cultus here being exhibited by the works, rather than by the relics.

There are no names which define or describe the stages of society here, such as are used in Europe, but those stages, nevertheless, exist, being shown here by primitive architecture, as they are there by primitive art. The ages which have been so clearly distinguished, and which depend upon the material of the relics found in Europe, have not been identified here, but the grades of society are shown by the material used in architectural struct-

ures, and so the lines of distinction are somewhat similar. The geographical lines separate the works, and the material distinguishes them. In Europe the different relics are found in the same locality, and successive stages of cultus have been discovered, being identified by the material used, as well as by other characteristics. It is supposed that successive waves of population have thus left their tokens; possibly different races have overrun the same locality. But the growth of society has been much more connected in Europe than in America. Here wide districts have separated the races and their works, and the ruins which are discovered in these districts are so unlike, that they indicate different lines of development, if not different ethnic origin. Wherever a succession of races has been discovered, we have found that some of the races had prevailed elsewhere, and intruded themselves upon the domain of others. The study of the works, peculiar to each geographical locality, has revealed this fact, for it is easy to trace the resemblances and so identify the works with the races. If there are earth-works found in Mexico and Central America, they are not the characteristics or predominant structures. If there are stone cysts and occasional stone-walls in the Mississippi Valley, still the earth works are the prevailing structures here. This identifying the architectural peculiarities of one locality, in the midst of the works belonging to another, has this advantage; it enables us to see the grades which architecture has reached and associate them with the different states of society. The only disadvantage is, that it prevents us from tracing any connected development; in other words, instead of blending together, as they do in Europe, the works are here separated in wide gaps; great difference in architectural forms being discovered. It is not difficult to trace the grades, but it is difficult to discover the connecting links.

We propose to examine the works which are peculiar to the different geographical localities and to compare them with one another, and so endeavor to ascertain if there was any separate line of development. The first class of works which we shall examine will be those which are known to have been erected by the Indian tribes and which prevailed, extensively, both on the Atlan-

tic and the Pacific coast. The second will be those found in the Mississippi valley which are generally known by the name of the Mound Builders works. The third, those found in the Great Plateau of the West, known as the Puebloes. The fourth class are those which belonged to the civilized races of Mexico and Central America. We might, indeed, also examine the works of the different geographical localities, and compare them, and so endeavor to ascertain whether there was any connection between them; that is to say, whether there was any development of one into the other. If the development is continental instead of local, it should be recognized. The transition from one to the other is so abrupt, that it is difficult to trace any connection. The architectural forms follow different types, and the whole character of the pre-historic works, in the separate localities, show a development so distinct that we can hardly find anything in common.

I. We shall consider first, then, the House Architecture, and, afterward, the Military Works, which are known to belong to the various Indian tribes.

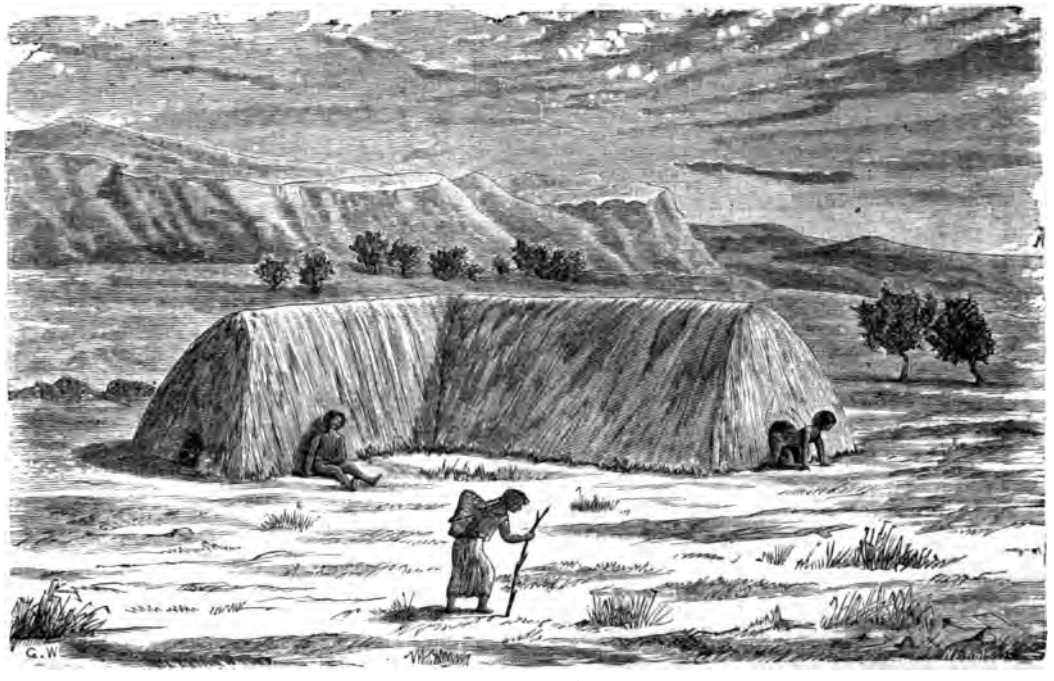
In considering the works of this class, however, we shall examine them in all localities, wherever the Indian tribes are known to have prevailed, and so compare them with the works of each locality.

We shall not, then, in this paper, undertake to trace any common type through the different geographical localities, but shall refer to those which are characteristic of the separate localities, and shall, by this means, undertake to show what different grades of architecture have appeared in the different portions of this continent.

We may see, also, that these different grades are associated with the different states of society; the first, with the hunter life; the second, with the agricultural; the third, with the village life; the fourth, with the civilized state.

In taking this position, we do not deny but that these different states of society and the corresponding architecture prevailed to a certain extent outside of the particular localities to which they

KUTCHIN LODGE.



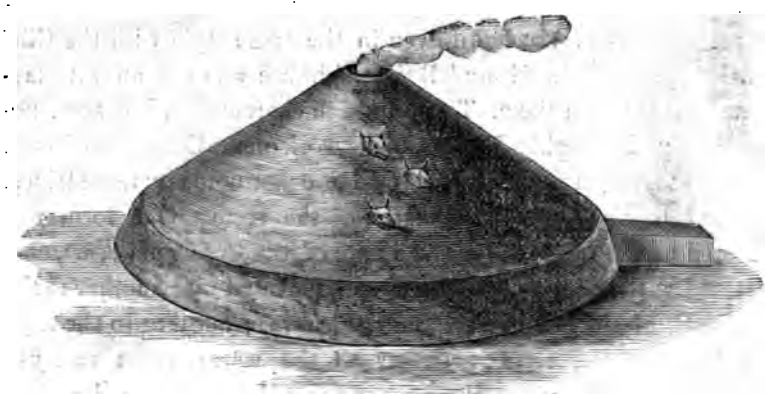
TULARE LODGE.

are ascribed. But they most abound and are best known in the localities to which they are referred.

We maintain that, whatever races built the separate works, the grades of architecture are so unlike as to show an entirely different social status. The mode of life and the social status corresponded, and the architectural grades partook of each.

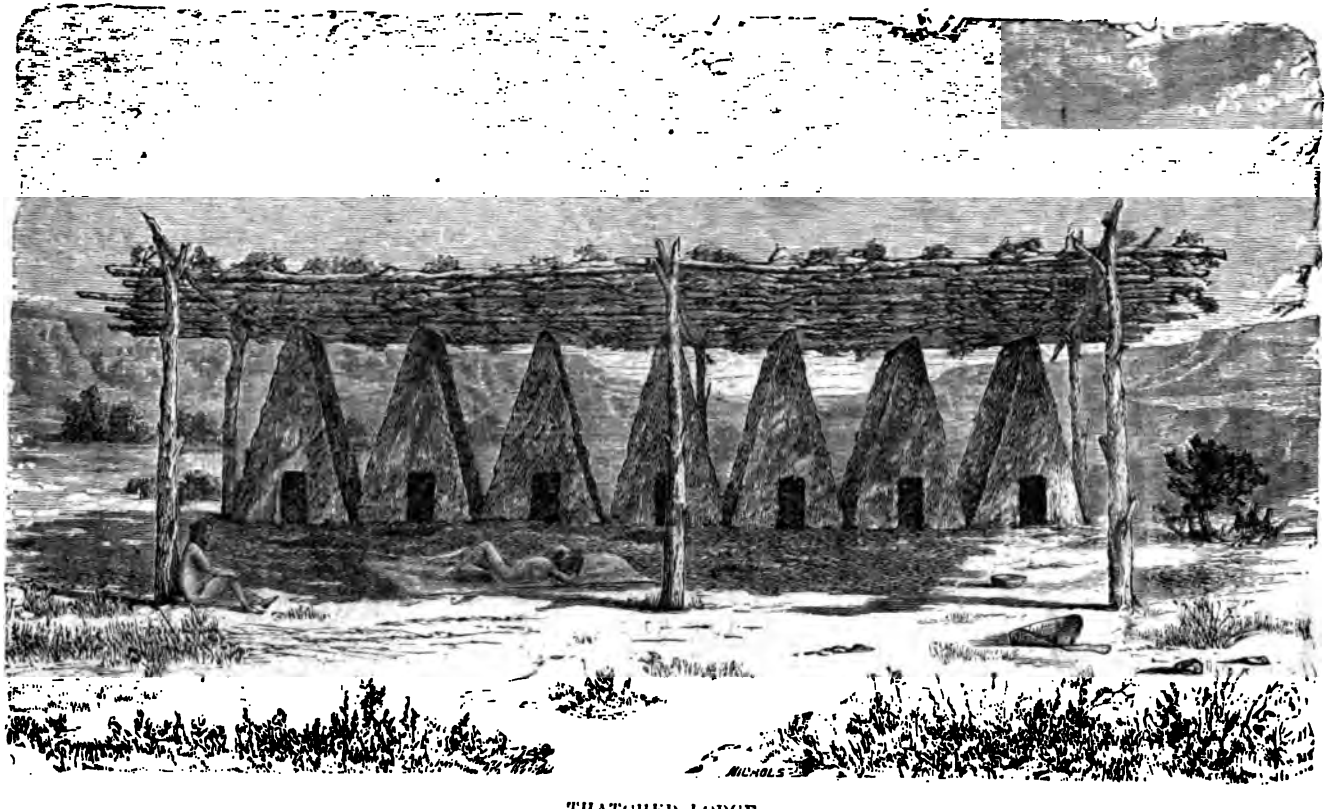
We proceed, then, to consider the house architecture of the uncivilized races. We do not need to refer to the Indian Wigwam, to show that this style of building was very primitive. There were many different methods of building houses among the Indians. It is difficult to say whether, under certain circumstances, they did not build even in the same style with the Cliff Dwellers, and if the Mound Builders' house was not an intermediate link between them. The primitive character is, however, noticeable. "Mr. Stephen Powers, in his work on the California Tribes, enumerates seven varieties of the lodge, constructed by these tribes, adapted to the different climates of the state. One form was adapted to the raw and foggy climate of the California coast, constructed with redwood poles over an excavated pit; another to the snow-belt of the coast range and the Sierras; another to the high ranges of the Sierras; another to the warm coast valleys; another, limited to a small area, constructed of interlaced willow poles, the interstices being open; another to the woodless plains of the Sacramento and the San Joaquin, dome-shaped and covered with earth; and another to the hot and nearly rainless region of the Kern and Tulare valleys, made of tule. * * * The round, domed-shaped, earth-covered lodge, is considered the characteristic one of California; and probably two-thirds of its immense, aboriginal population lived in dwellings of this description. The doorway is sometimes directly on top, sometimes on the ground, at one side." We give a cut of this form of lodge, and would call attention to the resemblance between it and the Maudan lodge. The Mandans occupied the country on the Missouri river, and their lodges have been described by Catlin in his North American Indians. The remains of similar lodges are found in quite considerable numbers in southwestern Iowa, many small circles of earth having been dis-

covered on the bluffs bordering the Missouri river, showing where the lodges had been located and were fallen down. The Kutchin Lodge is somewhat similar in form, but is generally covered with deer-skins dressed with the hair on. The Ojibwa cabin, which may still be found on the south shore of Lake Superior, was also similar; though it came to a point at the top, forming a perfect cone, and was covered with birch-bark. The Dakota lodge was constructed with a frame of poles; the poles, 13 in number, being from 15 to 18 feet in length, were tied together at the top, and a number of tanned buffalo skins were stitched together and drawn

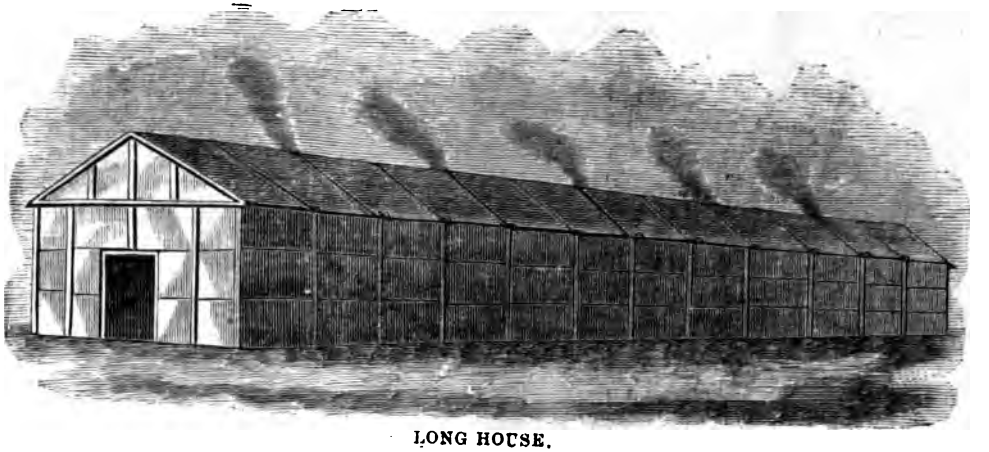


MANDAN HOUSE.

over these. The Winnebagoes, formerly in Wisconsin, built their lodges in the same way, but used rough mats for covering. This hemispherical or conical shaped house is probably the most common of any among the rude uncivilized tribes in all countries. Lodges, resembling them, are described as common in Africa. The Zulus to-day live in houses which might be mistaken for Indian wigwams, and even their palisades, which surround the inclosures where these lodges are situated, might also be mistaken for Indian stockades. A second form of lodge, found in California, is the one given in the cut which is taken from Mr. Powers' work. This wigwam is in the shape of the capital letter L, made up of slats, leaning up to a ridgepole and heavily thatched. There are three narrow holes, for entrance, one on either end and one at the elbow. Half a dozen such houses make an Indian



THATCHED LODGE.



LONG HOUSE.

village, with the addition of a dome-shaped assembly or dance house in the middle, or open space. One or more acorn granaries, of wicker-work, stand around each lodge, much like hogsheads in shape and size, either on the ground or mounted on posts as high as one's head, filled with acorns and capped with thatch. Similar to this style is the Yokuts lodge, also described by Mr. Powers. Every village consists of a single row of wigwams, conical or wedge shaped, generally made of tule, and just enough hollowed out within so that the inmates may sleep with the head higher than their feet, all in perfect alignment, and with a continuous awning of brushwood stretching along in front. In one end wigwam lives the village captain; on the other the shaman or *si-sê-ro.* In the mountains there is some approach to this martial array, but it is universal on the plains. Perhaps the most completely developed house was that found among the Iroquois. This has been described by L. H. Morgan, in his work on House-Life and House Architecture. It consisted of a strong frame of upright poles set in the ground, which were strengthened with horizontal poles, attached with withes and surmounted by a triangular, and in some cases with a round roof. It was covered over both sides and roof with large strips of elm-bark, tied to the frame with strings or splints. A similar frame work was then placed outside of the bark both along the sides and on the roof, and the two frames tied together, with the bark between. At each end was a doorway, covered with suspended skins. Within, the house was divided into compartments like stalls, a passage way running through the whole house from end to end. These long houses of the Iroquois were often 50, 80 or 100 feet long, and sometimes occupied by 20 families. (See cut on opp. page.) The Algonquin houses were built in a somewhat similar manner, a large, rounded house, from 50 to 80 feet in length, covered with matting in the place of bark, and large enough to accommodate several families.

The Iroquois and Algonquin tribes generally dwelt in villages. The village consisted of a number of tenement houses, arranged around a central open space, and surrounded with a palisade. Some of them were not enclosed with a palisade. These houses

have been described by Sir Richard Grenville, who visited Roanoke Island in 1655. An artist, John Wyth, who was with the expedition, has furnished a number of valuable sketches of these villages. The description of Pomeiock is as follows: "The towns in Virginia are very like those in Florida, not, however, so well and firmly built, and are enclosed by a circular palisade with a narrow entrance. In the town of Pomeiock, the buildings are mostly those of the chiefs and men of rank. On one side is the Temple (council house), (A) of a circular shape, apart from the rest, and covered with mats on every side, without windows, and receiving no light except through the entrance. The residence of their chief (B) is constructed of poles fixed in the ground; bound together and covered with mats, which are thrown off at pleasure, to admit as much light and air as they may require."

We have thus given, at considerable length, a description of the house-architecture of the different Indian tribes. We may discover in all these houses a very great similarity, and can easily perceive that a great difference exists between them and both the Pueblo houses of Arizona and the cliff-houses of Colorado and New Mexico.

We turn now to consider the stockades and military architecture of the uncivilized races. This architecture is well known for history has made a record of them. What history lacks, also archæology furnishes, for there are many remains of the forts and stockade-villages of the later Indians. These remains are found oftentimes, amid the works of the Mound-Builders, but they can be easily distinguished by their peculiarities. They consist of a simple, rude wall in the form of a circle, with a ditch on either side, but with no signs of any pains taken, either with their form or finish. They are generally found situated on the summit of some hill, near some stream or spring, and in places capable of defense as well as suitable for residence. They can be distinguished from the Mound-Builders' works, for these are much more massive, have a higher architectural finish, and were used for many other purposes than as defenses. There are many remains of stockades throughout Northern Ohio and in Michigan, where it is known that the Red Indians had their habitation, and where

country itself was favorable to the hunting life. There are a few such works found along the Ohio river and in the hern states, but they seem to have been intruded among other ks and probably were later in their origin and more transitory eing occupied. The habitats of the stockade-builder, how-, seem to have been New York State, and the regions east of Alleghany mountains. Vast numbers of their defenses and ges are now discovered upon the hill-tops of this region. . Squier has described no less than three hundred of them the State of New York alone. The works of the Mound-lders are distinguished from these not only by being in a dif-nt geographic locality, but by belonging to a different grade architecture. If the Mound-Builders were Indians, they e Indians in a higher stage of culture, for their works much more skill and a different state of society. warlike Indians would naturally erect stockades and make their predatory excursions and pursue their warlike in such regions as would furnish the best defenses. No e was more favorable to this than that very state where the Nations, the Iroquois, made their home. Surrounded on all s by mountain barriers or great bodies of water, they were in their retreat, yet they were so closely connected with other s of the interior, both by the lines of the Ohio river and its nches, by the great chain of lakes, and by the Ottawa river Canada, that it was with great ease that they could attack the abitants to the west of them. They overran the whole inte-; and subdued the wild tribes existing there.

We have only to imagine a similar history connected with er races at a previous date. The evidences of history are that tribes situated throughout this valley of the Ohio river, and upper Mississippi were, when first known to the white man, he same warlike state. The Eries, Wyandots and Shawnees, Miamis and Illinois, the Cherokees, and, perhaps, the Choc-s, were all in a migratory condition where it was impossible them to have attained any settled state, or to the agricultural dition. They were hunters, and seemed to have been so for y many years. It is probable that the remains of stockades

in the midst of the earthworks of this region, are the ruins of their habitations. By comparing these with others, which have been described by history, we shall be able to see that they represent a very different stage of development from the earthworks with which they are associated. We do not deny that some of the Indian tribes reached a high stage of development and attained to considerable architectural skill, but there seemed to be a great difference between their works, at their best, and the works of the Mound Builders, both in style and finish, and other peculiarities.

The Mound Builders may possibly have used stockades, and made their earth walls serve the purposes of parapets, and so their works would be only a development of this. Yet, even then we must ascribe different grades of architecture to the two classes of works. The material used is certainly different, and the style is different. The Iroquois built perpendicular structures, without any platforms, and depended upon the strength of timber for defense. The Mound Builders built their structures in the pyramidal style, and depended upon the strength of their earth-walls both for defenses and observatories.

The Cliff Dwellers and the Puebloes had a still different mode of defense. They erected perpendicular walls, but built in terraces, and depended upon adobé or stone as the material which should resist attack. Where they did not build in terraces, they put their houses into the niches of the rocks, and depended upon the Cliffs for protection.

That the ordinary Indian had a different grade of architecture from the Mound Builders or the Puebloes, is evident, also, from other circumstances.

II. We now turn to the works of the Mound Builders. I think we shall find among them, an entirely different grade of architecture and a different mode of life. We are not now considering the question whether the Mound Builders were Red Indians, or not, but whether their mode of life, their social status and their architectural skill were not all different from those with which we are familiar, as belonging to the Indian tribes. One of the first things which impresses us in this connection is the difference

in the locality in which the Mound Builders made their homes. The later Indians sought the forests and made their homes beside the rivers and lakes, but the Mound Builders either sought the prairies or the rich valleys, and erected their largest structures where the land was most fertile, and where the resources of agriculture were most productive. The conclusion is forced upon us that they were agriculturists. While there are many works which show that they depended upon hunting, and that they also were warlike and erected many works of defense, yet that the peaceful, agricultural life was the prevailing one, is evident. They certainly evidently selected the sites for their homes, more with a view to the agricultural advantages, than to the military. There are many military works which evidently belong to them, but their most complicated and elaborate structures are found in the most fertile regions, in localities favorable to an agricultural life, and yet so secure as to render their permanent settlement possible. The grades of architecture among the Mound Builders' works correspond to this idea, a wonderful correlation existing between them and the topography. The great capital of the Mound Builders of Ohio, for instance, was at Newark. Here it is plain that agricultural life was pursued. The great Circle at Circleville is also in the midst of a rich valley. The works at Chillicothe, at Marrietta, at Portsmouth, were all situated in rich agricultural regions; even Ft. Ancient, on the Miami, was on the borders of a high but fertile prairie, while the valley of the Miami below furnishes other facilities for culture, as well as resources in its waters. The Great Mound at Cahokia is situated in a fertile region, known as the Great American Bottoms, and shows, both in its vast dimensions and the number of surrounding works, that it was in the center of a thickly populated locality. The great mounds at Etowah and Eufaula, Georgia, are also in that fertile region which has been described by the early historians as occupied by a peaceful, agricultural people. Descriptions are given by the historians connected with Ferdinand De Soto, of great corn-fields, of numerous villages, of powerful tribes located on the rivers, of chiefs or *caciques* having their houses on the summits of platforms, and of an industrious and thrifty people. They

were certainly less war-like than the savage tribes of the north, whom La Salle and Hennepin afterward visited. Whether they were the builders of the works now existing, or were occupying the works of another people who preceded them, they were in the agricultural state. The massiveness of the pyramids or platforms of earth, found throughout this region, show that a sedentary people, who had long followed the peaceful pursuit of agriculture, and who had reached a high degree of architectural skill, had lived here. And so, throughout the whole valley of the Mississippi the evidences are accumulating that there was a stage of society, once existing here, quite different from that which ever prevailed among the savage tribes.

These savage tribes did indeed follow the agricultural life to a certain extent, and some of them reached a high state of development. The history of the Iroquois confederacy records the facts that there was not only a high state of political and social life among them, but that agriculture and architecture also reached some degree of development; but the description of their works by history, and especially as seen in the fragmentary ruins left by them, would indicate that the Mound Builders were far in advance in all these respects. If we can look at the amount of toil necessary to erect the great earthworks which are scattered over the country, we must ascribe to the Mound Builders an industry which never existed among the later Indians. It is said that the Mound of Cahokia covered an area of six acres, and its solid contents have been estimated at 20,000,000 cubic feet. It was 705 feet in length and the same in width, and rose to a height of 90 feet. It was built in two stories, the lower terrace having a breadth of 160 feet and length of 300 feet, and the upper terrace or summit affording a platform of 200 by 450 feet. [The Great Pyramid of Ghizeh is only 720 feet square, but has a height of 450 feet.] This is only one of sixty similar mounds which are found in the same locality. The great mound at Miamisburg is 68 feet in height and 852 feet in circumference, and contains 311,353 cubic feet. It is said that the mound was built as an observatory and overlooks the Big Twin river. It is situated on a hill just east of the Great Miami, and not only commands a

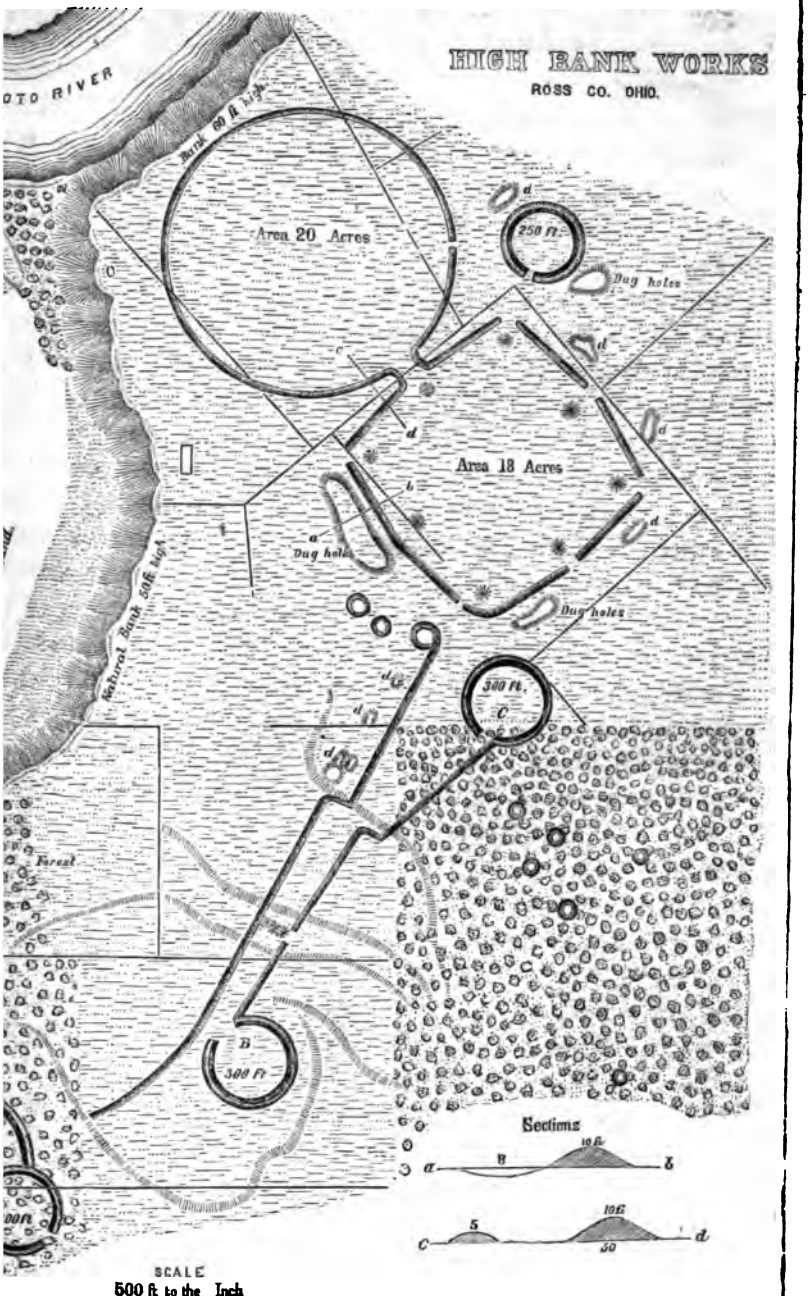
view of the whole valley of the river, but a beacon on its summit can be seen from another high mound in Butler county and from one at Springboro, and from the works at Ft. Ancient. The Grave Creek Mound is 70 feet in height and nearly 1,000 feet in circumference at its base. It was built, evidently, as a sepulchral mound; two vaults having been found in it, which contained at the time it was opened over 3,000 shell beads, several bracelets of copper, various articles carved in stone and a number of ornaments. A stone mound once existed near Newark, O., made up of stone laid up without cement, 52 feet high and a circular base of 182 feet in diameter. During the year 1831–32 not less than 50 teams were employed in hauling stone from it, and carried away from 10,000 to 15,000 wagon loads. The Big Mound in St. Louis was 150 feet in length and 30 in height. Within this was also a sepulchral tomb, 8 to 12 feet wide, 75 feet long and 8 to 10 feet in height, in which from twenty to thirty burials had taken place. The great mound at Seltzertown, Mississippi, is in the form of a truncated pyramid, about 600 by 400 feet at its base, and covering nearly six acres of ground. It is placed to coincide with the cardinal points, its greater length being from east to west. It is 40 feet high, and reached by a graded way leading to a platform on the summit, whose area is four acres, and from which rise three, conical, truncated mounds, about 40 feet in height, and eight smaller ones.

The Messier Mound, Early county, Ga., is in the form of the frustum of a rectangular pyramid, 66 by 156 feet at the summit, which is a level plane. The base measures, northern side, 188 feet; southern side, 198 feet; eastern and western sides, 324 feet each. This tumulus contains 75,000 cubic yards of earth, and would weigh from 90,000 to 100,000 tons, to remove which, by modern means, would cost $50,000, under the same conditions that would require the labor of 1,000 savages one year with the aid of baskets, etc., for the transfer of the earth.

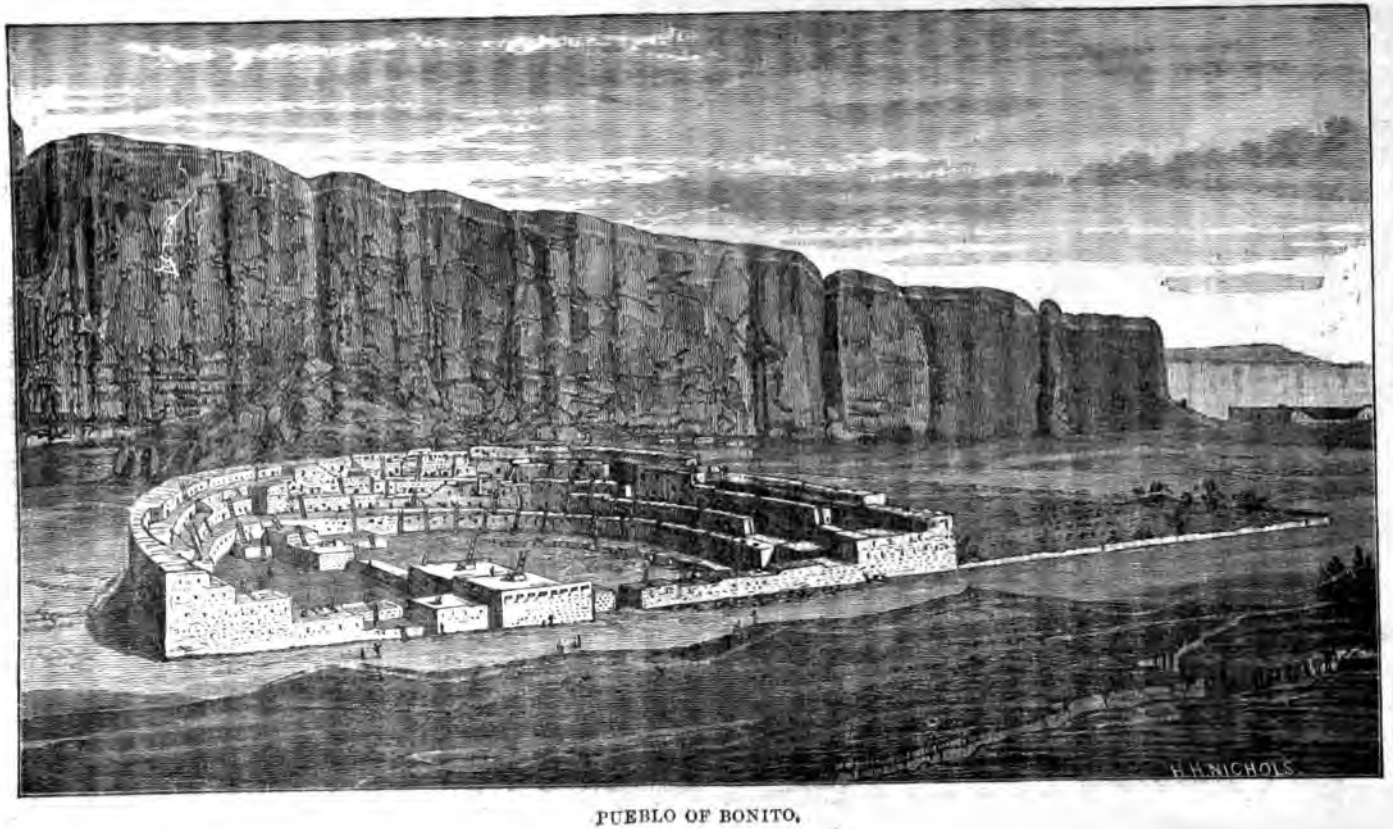
In speaking of these latter mounds, Hon. C. C. Jones says: "Upon even a cursory examination of these groups of mounds with their attendant ditches, earth-walls and fish-preserves, it is difficult to resist the impression that they are the remains of

a people more patient of labor, and, in some respects, superior to the nomadic tribes which, within the memory of the whites, clung around and devoted to secondary uses these long deserted monuments. There is not a considerable stream within the limits of Georgia in whose valleys tumuli of this sort are not to be found. They appear in Florida and are frequent in Alabama, where truncated pyramids are even more abundant. Tennessee, South Carolina, Mississippi and Louisiana are dotted with interesting monuments of this class. The occupation of this region by the Mound Builders was by no means inconsiderable. It is in fertile valleys and upon alluvial river-flats, whose soil afforded ample scope for agricultural pursuits, that these tumuli are mainly seen.

There are many works which show the cultus and the social status of the Mound Builders, and these all indicate that the mode of life prevalent among them was entirely different from that which we know to have existed among the ordinary tribes of Indians. The complicated and elaborate system of earth-walls which surround the so-called military, sacred and village enclosures, the various excavations which formed the moats which protected their villages, or ponds for the preservation of fish, the many graded ways which formed the entrances to enclosures, and the many platforms and other structures which were discovered in those enclosures, all show that the society among the Mound Builders had reached a stage where all the varied offices known to civilized life were already common, and where a complete organization had begun to appear. The evidences are, that the Mound Builders were agricultural, and having passed beyond the unsettled condition of the savage races, occupied a position intermediate between the hunter races of the east and the Puebloes of the west, and were also in that social state which formed a connecting link between the two. The term Village Indian has been applied to them, but we maintain that while village life evidently prevailed among them, it was not their distinctive peculiarity. A residence in collected bodies was common throughout all the grades and states. This was owing partly to the communistic state and the tribal organization; but the term Village Indians does not express their status. They were not in that



MOUND BUILDER'S CIRCLE.



PUEBLO OF BONITO.

condition which we know to have prevailed among the Puebloes where the communistic state reached such perfection, and where the social organization was so compacted. Nor were they, on the other hand, mere confederate tribes, who were full of warlike exploits, nomadic in habit, and scarcely out of the hunter state, but they were evidently agricultural, sedentary and thoroughly organized. We quote again from Mr. Jones, who seems to have apprehended the true status of this unknown people: "Why the older Indian tribes should have erected monuments so much more substantial and imposing than those which were constructed by the modern Indians, it is difficult to say. Forming permanent settlements, they devoted themselves to agricultural pursuits erected temples, fortified localities, worshipped the sun, possessed idols, wrought largely in stone, fashioned ornaments of foreign shells, and occasionally of gold, used copper implements, and were not entirely improvident of the future. Such was the fertility of the localities most thickly peopled by them, so pleasant the climate and so abundant the supply of game, that these ancient settlers were in great measure relieved from that stern struggle which, among nomadic tribes and under more inhospitable skies, constitutes the great battle with nature for life.

We present a cut to illustrate one class of works common among the Mound Builders, taken from the work of Squier and Davis, with it we find the following description: "The principal work consists of an octagon and circle, the former measuring 950 feet, the latter 1,050 feet in diameter. * * The walls of the octagon are very bold, and, where they have been least subject to cultivation, are now between eleven and twelve feet in height, by about fifty feet base. The wall of the circle is much less, nowhere measuring over forty or fifty feet in altitude. In all these respects, as in the absence of a ditch, and the presence of the two small circles, this work resembles the Hopeton works." Of the latter, which is nine miles above on the Scioto, they remark that "the walls of the rectangular work are composed of a clayey loam twelve feet high by fifty feet base. * * They resemble the heavy grading of a railway, and are broad enough on top to admit of the passage of a coach."

III. We turn then, in the third place, to consider the architecture of the Pueblos. The name *Pueblo* signifies *village*, and we shall find that village life is better represented by them, than any other people. This life is indeed compact and concentrated, a whole village being often contained in a single house, a house constituting a village. But if a numerous population and the concentration of a large number of families into one locality, constitutes a village, we certainly have the essential feature of village life, here.

Ordinarily the different occupations of villagers are pursued separately. Either the houses will be distinct, or the people who dwell in them will follow these occupations separately, with the places where they labor, removed from their residence. This is so in civilized countries. There is an approach to the Pueblo life in some of our cities, where the blocks of houses are so similar and so connected, and where the people swarm out from apartment which are constructed exactly the same.

Village life is less compact than city life, and we might properly consider that it was the life, which both the later Indians and the earlier Mound Builders pursued. In that case we should class the Puebloes with city architecture, and ascribe city life to the Pueblo Indians. We have preferred, however, to use the term *village* life here, and if we were to ascribe city life to any people, would refer it to those races who have left their ruins to the southwest; i. e. the civilized races of America. There was a necessity for this concentrated life among the Puebloes, as the country which they occupied would not admit of a wide spread population. The mesas which stretch from valley to valley throughout this whole region where the great plateau of North America is found, are barren, rocky and uninhabitable. The only places which admit of settlement and afford the means of living to any number of people, are the valleys of the streams.

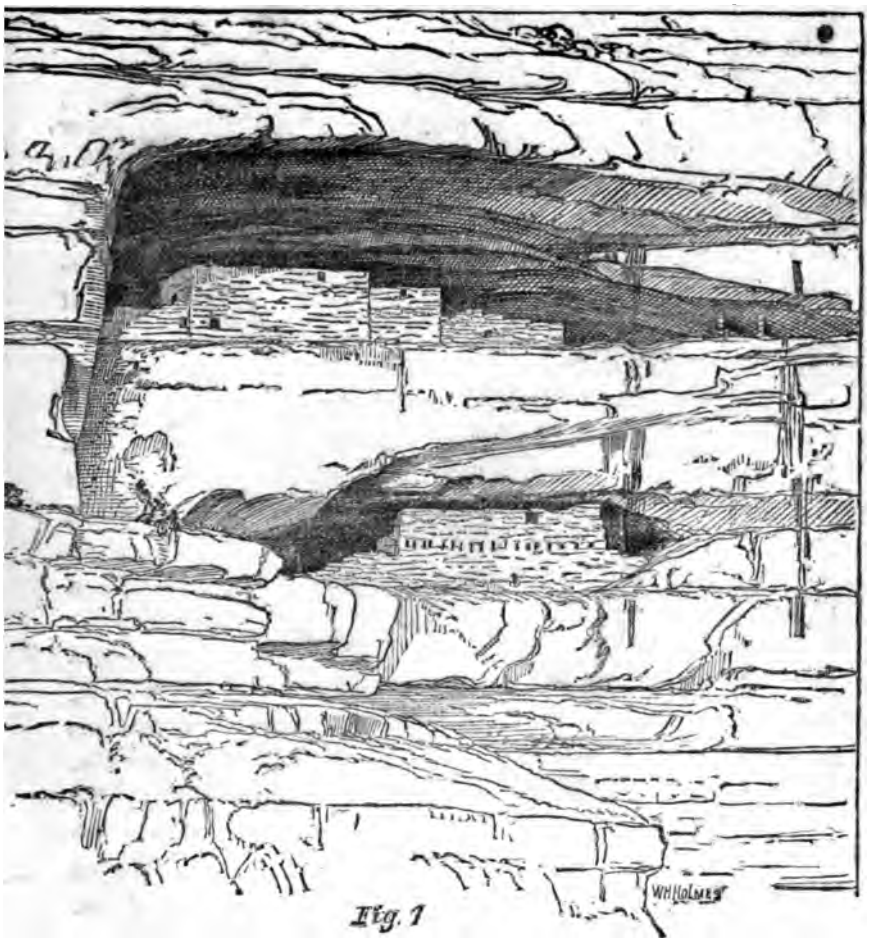
Mr. L. H. Morgan says that New Mexico is a poor country for civilized man, but quite well adapted to sedentary Indians, who cultivate about one acre out of every 100,000. The region is composed of valleys which intervene between the mesas, though the cañons here are less abrupt and are wider in extent than in

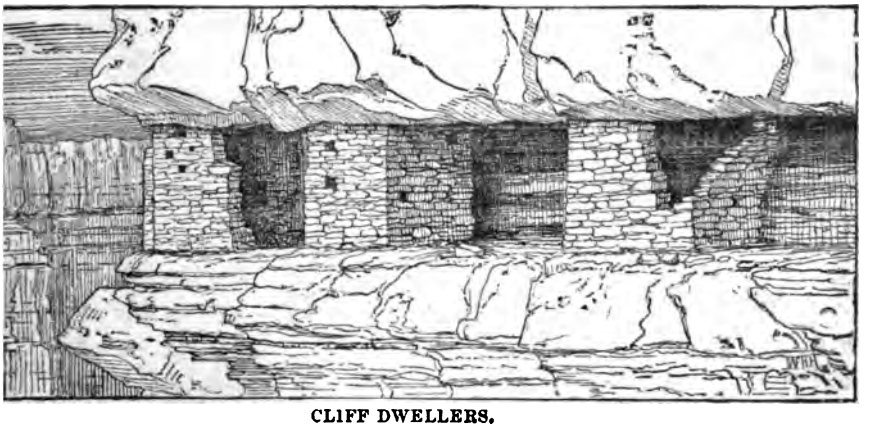
many other places. The cañons grow deeper and more inaccessible as one travels southward. There are places where the level plain between the walls of the cañon range from half a mile to a mile. Such is the cañon of the Rio Chaco in New Mexico. The Anamas and San Juan rivers, which are both tributaries of the Colorado river, contain many puebloes, but are lined with valleys which extend, in places, even to three miles in width. The Montezuma valley is a broad and level plain, 50 miles in length and 10 miles wide. The bluffs bordering the eastern sides rise boldly 1,500 feet. This whole district has great importance as an early seat of village Indian life. The ruins which are found in the valleys of the San Juan, Pine, La Plata, Anamas, Hovenweep rivers and the Rio Dolores, show that this remarkable area has held a prominent place in the first and most ancient development of village life in America. The number of puebloes found in the valleys of these rivers cannot be stated, but from these reports of the United States exploring expedition and other sources, we learn that these pueblos, both ancient and modern, are scattered thickly throughout the whole region. There are at present about twenty pueblos in New Mexico. Beside these there are about seven pueblos of the Moquis, near the Little Colorado. The most important of these are the celebrated villages of the Zunis, those in Santo Domingo, Tusayan, Taos, Jemez, Zia, Jose Miguel. These are at present occupied, and are supposed to be the same places which Coronado visited in 1541, and their present occupants are the descendants of the people who lived in them then. It is probable that some of the houses have stood during the 340 years which have elapsed, and are the same as they were with the exception of a few modern improvements. Mr. L. H. Morgan thinks that the villages of the Zuni are the same as the Seven Cities of Cibola, so noted in history. In the center of a plain, upon a commanding eminence, stands the inhabited Pueblo. Its frontage is upon the river, where but a short distance in the background the mesa terminates in tall cliffs, several hundred feet high. The town is built in blocks, with terraced shaped houses, usually three stories high, in which the lower stories do service as the platform for those above. The town is

compactly built, many of the streets passing under the upper stories of houses. The whole is divided into four squares and the houses in each are continuously joined together. Building material is stone, plastered with mud. Near this, two miles to the southeast, situated on an elevated mesa a mile in width, the precipitous descent from which measures 1,000 feet, are the ruins of old Zuni.

Beneath the walls of this antiquated ruin, others of a more ancient city are found, whose walls are six feet thick, the city having perished before the present was begun. It appears then that one type of building prevailed through many ages, the same kind of structure having been erected throughout a very wide district of country. There is, however, a difference in the style of architecture in this region, which is embraced between great ranges of mountains, varying according to the belts of latitude, as much as it is defined and limited, by the longitudinal lines. To the northward, the houses are but one story, and do not differ essentially, from those of the wild Indians. Within certain parallels the houses are of the type before referred to, being built in terraces, and on the level of the plain, undefended, except by their own walls. Farther south, the houses are placed on the niches of the cliffs, and are raised above the valleys, and assume many different shapes. Descriptions of the terraced houses have been given. They seem to have combined all the characteristics of dwelling-houses, of village enclosures and of defense. The upper story is narrower than the one below, so that there is a platform, or landing, along the whole length of the building. The house-tops were used as they are in Oriental countries, as the social gathering places. This terraced form of architecture is the typical one throughout New Mexico, Colorado and Arizona.

The buildings are sometimes straight, with wings running to the front, at right angles, thus forming a rectangular square. Others are built in a semi-circular form with the terraces rising like an amphitheatre around a hollow square. These houses are sometimes three, four or five stories high, and reach great dimensions. The material of which they are constructed is sometimes adobè and sometimes stone. The elevation of these Pueblo





CLIFF DWELLERS.

Houses, have, from time to time been published. We present herewith, a a restoration of the Pueblo of Bonito, which was published in Morgan's work, and previously in Hayden's Annual Report. This restoration was made by Mr. Simpson, after the study of a large number of houses of the same type. The Pueblo houses varied in size, some having a main building 250 feet in length, some, 300, and some even larger. They are generally erected with wings of proportionate length, and contain oftentimes 120 and 140 rooms. The lower stories were used for storehouses; the upper stories for the residences of the families, and the highest story as the residence of the *cacique* or head man of the village. The walls on the outside were solid and inaccessible: on the inside, toward the court, there were no doors, but the upper stories were reached by ladders which could be taken up, and thus leave the house like a castle, isolated and raised above the plain, and inaccessible. There is no doubt that the communistic system prevailed among the Pueblos.

The cliff-dwellers' dwellings differ from these very much in appearance, and yet they are built on the same plan, and indicate the same mode of life. The residences were not always connected, and village life was not as compact. The inhabitants clung to the cliffs for defense, and scattered their store houses, their *estufas* and their dwellings along the sides of the precipice and on the edge of the *mesas*, wedging in their abodes wherever a shelter was afforded by the rocks.

The style of architecture prevalent among the cliff dwellers seems to be in great contrast to that prevalent among the Pueblos, but if we analyze and take the component parts of the Pueblo, and then scatter them over the cliffs, we shall find that all the elements are here. Sometimes the *estufa* is placed on the *mesa*, and sometimes it is crowded in between the other chambers under shelter of the cliff. Small rooms are divided off and used for store rooms. The buildings are not often more than one story and lack the terrace form which is peculiar to the Puebloes.

But it is evident that the same mode of life was prevalent in each; the valleys below furnished the provisions for the people, and the inhabitants issued from their rock shelters, just as they

did from the many storied Puebloes, to cultivate the soil below, and then transported the products to their store houses, high up among the rocks. The ascent to these cliff houses was sometimes quite difficult, the height at which they were erected being in places several hundred feet. A cliff house visited by W. S. Jackson has a height of 600 feet above the bottom of the cañon, 100 feet of it almost perpendicular wall. The ledge was ten feet wide by twenty feet in length. The same party discovered a cave village, perched up upon a recessed bench, 70 feet above the valley; the total length of the town being 545 feet, with a width in no place more than 40 feet, an *estufa* or council hall being built also into the cliff in the midst of the town; and two rows of rooms also erected in the shelter, the outer row for residences and the inner row for store houses.

On the San Juan river, thirty-five miles below the mouth of the La Plata, and ten miles above the Mancos, Mr. Holmes observed an interesting combination of cave-shelters and towers united in a system for giving signals upon the approach of the enemy. In the face of a vertical bluff 35 feet high, and about half way from the trail below, caves had been quarried or weathered in considerable numbers in the shales which constitute one of the strata in the bluff. A hard platform of rock formed the floor, and afforded sufficient protection for a narrow platform in front of these openings. Immediately above these caves upon this summit of the bluffs, a system of ruined circular towers, enclosed with semi-circular walls, with the open side of the semi-circle facing the precipice, was observed. The caves were accessible from the valley below only by means of ladders, and the towers, in turn, only by ladders from the caves, through the open side of their semi-circular enclosures. The walls of these enclosures presented no openings to the plateau above, and it is inferred that the towers which they enclosed served as outlooks, from which the sentinel could signal the people who were engaged in tilling the valley below to flee to their cave-shelters at the approach of the enemy, and when too closely pressed by an enemy upon the plateau, the sentinel himself could make his retreat by means of his ladder to the caves beneath.

The most remarkable cliff-dwellings discovered by Mr. Holmes are shown in the cut.

These extraordinary fortresses, lodged in caves 800 feet above the level of the valley, are situated in the canon of the Mancos, a few miles from its mouth. The first 500 feet of the ascent from the level of the stream is over a rough, cliff-broken slope; the remainder of massive sandstone full of inches and caves. The upper house is situated in a deep cavern with overhanging roof about 100 feet from the cliff's top. The front wall of the house is built upon the very edge of the giddy precipice. The larger house is lodged in a niche or cave 30 feet below. The lower house was easily accessible. The wall was built flush with the precipice, and remained standing to a height of 14 feet at the highest point, though other portions had crumbled away considerably. The house occupied the entire floor of the niche, which measures 60 feet long by 15 wide.

III. We draw this paper to a close, with a few words in conclusion, concerning the architecture of Central America. It was the effort of our distinguished friend, Mr. L. H. Morgan, to take away the glamour and correct the falsehoods which had gathered around the antiquities of this region. It has seemed to us, however, that he went to the other extreme, especially when he represented the ancient inhabitants as Indians, wearing breech-clouts and scarcely different from those whom we know as the "savages" of North America. There may have been indeed many imaginary pictures of the condition of the cities which the Spanish Conquerors entered, but there are enough ruins of these cities to indicate that a barbaric magnificence did prevail there. We are convinced that the national life had begun, for a much higher grade of architecture certainly existed there, and the ruins show that the people had passed out from the village life, into a state which resembles, in many respects, the artificial and magnificent state which is peculiar to civilization. City life may better express the idea than any other term. We do not propose to argue this point, but refer to it and leave it to our readers to decide whether the sculptured and highly adorned buildings were not in fact, as they are called in name, palaces. The communistic mode

of life will account for many things, and is a good, working hypothesis, but we cannot class all the pre-historic inhabitants together, and call them Indians, for the works which they have left behind them, and the different grades of architecture seen in these show to us clearly that different modes of life and a different social status prevailed in each geographical district, the grades of architecture being correlated to them.

There has been, in our opinion, too much said about the builders of the pre-historic works being all of them Indians. We might as well talk about the historic works of the east being built by man. One term is about as generic as the other. In Australia the word *natives* denotes the white residents born in the island, but the word *aborigines* signifies the races which were found there. If we could make the distinction between Indians and Aborigines calling only those Indians who are known to history as the hunters and savages, and call the rest by some other name, we should be saved a great deal of confusion.

They were, no doubt, all of them Indians and Aborigines, having similar ethnological peculiarities and possibly the same origin. But there was as much difference between these same Indians as between the races of whites. We talk about Irish, Dutch and English, and understand that the social life and architectural taste of these races are very different. But they were not so different as those found among the Indians. In fact, the European races are a good deal nearer to one another, both in territorial proximity, ethnic affinities, and social status, than were any of the native American races. The Europeans have, to be sure, reached the position where property in severalty is held, and where landed estates and family names separate households. The American acres were in that tribal condition, all of them, where the communistic principle prevailed. The tribal organization was universal, but the social status in the different geographical localities and among the different tribes, was very distinct. If America were compared to Europe in the times of Julius Cæsar, this would be better understood. At that time Britons, Gauls, and Goths were occupying the north of Europe. They were the uncivilized races.

The civilized races were found in Italy, Greece and a part of Spain. They were all Indo-Europeans and had a common origin. In fact, they all belonged to the White race. The American aborigines all belonged to the red race. Some were civilized and some uncivilized.

The works of the Britons and of the Iroquois may be compared. The Gauls or Celts may be considered the Mound Builders, or what is better, perhaps, the Iberians. The German tribes may be compared to the Pueblos, and the Romans to the Mexicans. There was a great difference between the Cis-Alpine and Trans-Alpine races. Civilization prevailed at Rome, and much of it was borrowed from the far east. Barbarism prevailed north of the Alps, and the races came from another stock. So the civilization of Mexico and Central America may have been derived from across the water, in one direction or the other. The Aztec, Toltec, and the Chicrinec races may have come from a different stock from the uncivilized races, situated north of Mexico; the grades of society and the stages of architecture were very different, not so different as those which prevailed in Europe, yet different enough to be recognized now in the ruins and monuments. We present a cut with this article which represents one of the palaces which were common in Central America.

Mr. H. H. Bancroft has, in his Native Races of the Pacific Coast, referred to a large number of just such structures. The ruins of Uxmal and Palenque are often described, but these are only types of many which were common. The elaborate carving on the façades of these palaces, the many and complicated halls and chambers which were within, the magnificent corridors and courts which were without, and the whole style of architecture peculiar to the region, show that the people had reached a high stage of development. There must have been a barbaric magnificence which was impressive and strange, and we do not wonder that the Spanish historians represented them in such glowing colors as they did.

Whether evidence will be presented, in the course of time, that this skill and culture were trained by those who had known something of the civilization of other continents or not, we can

not deny that the architecture of this region shows a very different condition of life from that presented elsewhere. The soil and climate may have been favorable, and the increase of wealth and ease may have resulted in just such magnificence without any borrowed skill. But certainly there is a great contrast between these works of the civilized races, and the rude wigwams of the savages. All these different styles and grades of architecture may have had a common origin. Possibly the growth may be traced from the one to the other, but we can no more compare the Montezuma of Mexico to the Hiawatha of the Iroquois, than we can the Julius Cæsar of Rome to the Ariovistus of the Germans.

It is very fashionable to follow an idea, and to imagine that one system will explain them all; but the plain facts disprove all theories. Indian or not, modern or not, the works of Mexico and Central America show that the races there certainly reached a very different state of development from what prevailed north of this region. There is no wonderful mystery about it, and nothing improbable. The Seven Cities of Cibola, situated as they were in the deep inierior of this continent, struck the Spaniards with as much surprise as did the palaces of Mexico. The strange works of the Mound Builders have not yet ceased to excite our wonder and baffle our investigations. Only the familiar and rude ways and works of the Indians excite our contempt. But all of them are important, as showing what different states of society have existed on this continent, and how one dark-skinned, copper-colored race have developed into so many different stages of cultus. We take the four or five classes of architectural works and trace in them four or five different modes of life and social conditions, and so have a picture of the pre-historic ages on this continent which cannot be excelled. The study of primitive architecture is really the main source of information in reference to this age.

PROCEEDINGS OF THE ACADEMY SINCE JULY, 1878.

REPORT OF THE SECRETARY.

NINTH REGULAR ANNUAL MEETING,

Held at Madison, December 27, 28 and 29, 1878, in the Senate Chamber of the Capitol.

FIRST SESSION.

THURSDAY, December 27, 1878.

Academy met at 7:30 P. M., Dr. P. R. Hoy, presiding. Reports from the secretary, treasurer and various committees were read and accepted. Pres. Hoy then delivered his retiring address. After thanking the members for their kindness manifested toward him during his term of office, Dr. Hoy proceeded to briefly relate some of the wonderful discoveries of the recent past, rather than give the usual review of the work of the academy. The labors of Edison, Prof. Draper and various travelers were noticed. Dr. Hoy alluded to the rapid growth of the Academy, which started eight years ago with but eleven members. The address closed with a feeling tribute to deceased members, including the late Prof. Carpenter, whose recent death was severely felt at Madison.

"Did Bacon Write Shakspere?" a paper by Prof. Albert Hardy, of Milwaukee, followed.

The question of the authorship of Shakespere's plays was one of recent growth. Carefully collected facts were introduced to show the high regard which was accorded Shakespere by his contemporaries. The growth of the drama was depicted. A large number of passages taken from Shakespere and Bacon were cited to present the similarities and difference of the two writers. A strict analysis of the style reveals many intricacies of expression, which would escape a less careful scrutiny. From such an analysis the author of the paper was ready to ascribe to Shakespere the authorship of the plays which have immortalized his name.

"The Origin of the Township," a paper by Prof. Allen, of Madison, was read next. It consisted of a brief outline of the history of the organization of townships in France, Germany and England.

After the reading of this paper, a committee was appointed to report on the death of Prof. Carpenter.

Adjourned.

SECOND SESSION.

December 28th, 9 A. M.

After the election of several new members, Dr. Birge, of the State University, read a paper on "The Theories of Hæckel and Nægeli on Variation.'

Nægeli refers variation to internal forces; Hæckel to external forces exclusively. Neither theory is a complete explanation of the facts. Nægeli offers a teleological explanation as causal, and Hæckel calls in the grotesque conception of the "atom soul" to aid his mechanical forces.

Gov. Smith was introduced to the Academy by Pres. Hoy. Gov. Smith pleasantly responded.

"The Corals of Delafield" was the title of a paper read by I. M. Buel, of Beloit. [See page 185.]

An interesting paper, entitled "Some Observations on the Recent Glacial Deposits of Wisconsin and those of Switzerland," was read by Prof. T. C. Chamberlin, state geologist. The writer correlated the glacial deposits of Wisconsin with those of Switzerland. Stereoscopic views of the glaciers in Switzerland were left at the disposal of the audience.

The meeting adjourned at 12 o'clock.

THIRD SESSION.

December 28, 2 P. M.

The afternoon session was opened by a paper relating to "Some Points in the Geology of the Region about Beloit," by Mr. G. D. Swezey, of Beloit College.

The paper following this was entitled "The Penokee Fault," by Prof. R. D. Irving, of the State University.

The description of the "fault" was illustrated by a map showing that the magnetic belt or iron ridge had upon one side of "Bad river" slipped 800 feet below the corresponding ridge on the opposite side. Many interesting facts were noted in connection with this displacement and the various guesses as to the manner in which it had been produced were mentioned.

Prof. Chamberlin next gave a careful and graphic description of the tornado which occurred May 23, 1878, in Western Wisconsin. Prof. Chamberlin was at Mineral Point with a party of explorers, and was able to watch the phases of the storm and study the character of the cyclone. His remarks were verbal, and prefaced the more elaborate description of the same storm in a paper entitled "The Retardation of Wind in Tornadoes," by Prof. Daniells, of the University.

The history of the storm in Wisconsin was only a fraction of its history — its terrestrial career. The signal service had traced its origin to the Pacific coast. Tornado clouds were noticed in Texas, and various meteorological disturbances observed in many regions remote from where the cyclone struck the earth. Along the line of the storm — 65 miles — people who noticed it saw wind clouds moving from various quarters and coming together before spending their fury on the earth, thus giving rise to the idea that it was here

that the storm originated. But Prof. Daniells is quite convinced that it was here that it first struck the earth. The storm passed over 128 miles of space in 4 hours time. The velocity was registered at various points along the route and the retardation calculated. The distribution of the debris was noted.

The paper was discussed by Prof. Chamberlin, who took issue with Prof. Daniells' theory of the non-local origin of the cyclone.

The Academy adjourned at 4 o'clock to visit Science Hall, on invitation of Pres. Bascom of the University. This building is admirably adapted for the scientific work for which it has been erected.

Fourth Session.

December 28, 7:30 P. M.

The evening session was opened by the election of officers.

Dr. Chapin, of Beloit, was elected president. A resolution was adopted providing for the immediate election of three vice presidents of the departments of Science, Arts and Letters, respectively, and for the postponement of the election of the remaining department officers until the next meeting.

The following officers were then elected:

Vice President Department of Sciences — Prof. R. D. Irving, Madison.
Vice President Department of Arts — Hon. G. H. Paul, Milwaukee.
Vice President Department of Letters — Dr. G. M. Steele, Appleton.
General Secretary — Dr. J. E. Davies, Madison.
Treasurer — Hon. S. D. Hastings, Madison.
Curator of Cabinet — Prof. G. W. Peckham, Milwaukee.
Librarian — Dr. E. A. Birge, Madison.

A memorial of Dr. J. B. Feuling, written by Dr. S. H. Carpenter, was read by Prof. Allen. This was followed by a paper by Mrs. A. W. Bate of Milwaukee on the "Regime of the Nursery," which indicated the proper regulations for the nursery in order to secure the most beneficial results to young children. The subject was considered under the heads of physical, ethical and intellectual culture. Physical culture is the basis of all; hygienic regulations should be carefully enforced. Ethical culture should be taught by parental example. Responsibility should be gradually given to the child. The very young child should never be crammed with book knowledge. Make home a home.

The following amendment to the constitution was proposed by Prof. Allen and laid over until the next meeting, under the rules:

Resolved, That section 3 of the constitution be amended so as to reduce the number of departments to three, viz.:

Department of Sciences.
Department of Arts.
Department of Letters.

And that the existing amendment to section 3 be repealed.

Adjourned.

FIFTH SESSION.

MADISON, December 29.

Academy met pursuant to adjournment. Vice Pres. Steele in the chair.

Dr. E. A. Birge elected secretary *pro tem.*

Report of Committee on the Treasurer's Report made and accepted.

On motion the Academy proceeded to the election of the secretaries of the several departments, the election of the remaining department officers being postponed as by previous arrangement.

The following officers were elected:

Secretary of Department of Arts, Prof. J. J. Elmendorf of Racine.

Secretary of Department of Letters, Prof. W. J. L. Nicodemus of Madison.

Secretary of Department of Sciences, Prof. A. J. Rogers of Milwaukee.

The president, secretary and librarian were constituted a committee to provide for the care of the museum and library with full powers.

Academy adjourned *sine die.*

TENTH REGULAR ANNUAL MEETING,

Held December 29, 30 *and* 31, 1879, *at Madison, in the Senate Chamber of the Capitol.*

FIRST SESSION.

MADISON, DECEMBER, 29, 1879.

The meeting was called to order by President Chapin at 7 o'clock, P. M. Minutes of last meeting read and approved.

A committee of five was appointed on the revision of the constitution and by-laws of the Academy. Such committee consisted of Prof. J. E. Davies, Prof. E. A. Birge, Prof. J. J. Elmendorf, Prof. T. C. Chamberlin and Dr. P. R. Hoy.

Committee on Nominations was appointed, consisting of three members—Prof. W. C. Whitford, Prof Alex. Kerr, and Hon S. D. Hastings.

Dr. Birge submitted his report as Librarian, and recommended: 1st, that printed labels be procured for the bound volumes and pamphlets of the Academy's library; and 2d, that a printed form of acknowledgment of gifts to the library be secured. Report adopted.

Hon. S. D. Hastings submitted his report as Treasurer as follows:

TREASURER'S OFFICE,
WIS. ACAD. S. A. AND L.,
MADISON, Dec. 29, 1879.

Rev. A. L. CHAPIN, D. D., Pres.:

Sir—The following is a statement of the financial condition of the Academy at this date:

1879.		
Jan. 13.	Received from Gen. Geo. P. Delaplaine, former treasurer	$703 19
Dec. 25.	Received one year's interest on permanent fund.....	70 00
		$773 19

Warrants duly signed by the President and Secretary have been paid as follows:

1879.		
Jan. 24.	To Henry Mason, clerk hire	$12 50
Feb. 1.	To Henry Mason, wrappers, twine, etc	5 00
1.	To Henry Mason, postage on 100 vols. Trans	8 00
1.	To David Mason, balance due on account, 1879	8 55
17.	To Henry Mason, postage	8 00
21.	To Democrat Printing Co	5 25
Mar. 6.	To Henry Mason, expressage	10 00
22.	To Henry Mason, clerk hire	10 00
Apr. 26.	To Henry Mason, clerk hire	12 00
26.	To Henry Mason, expenses	14 25
May 24.	To Henry Mason, package for London	11 00
Sept. 2.	To David Atwood, for programmes	7 50
Oct. 21.	To W. J. Park, binding	43 50
	Total disbursements	$155 64

Total receipts, $773.19; balance on hand, $617.74.

The permanent fund of $1000 was loaned by my predecessor to Messrs. Delaplaine & Burdick for the term of three years from the 1st day of January, 1878.

I hold their two notes of $500 each, secured by mortgage on 23 (twenty-three) improved city lots in Madison.

The notes draw 7 per cent. interest, which has always been promptly paid.

Respectfully submitted.

SAMUEL D. HASTINGS,
Treasurer.

The report was referred to an auditing committee consisting of Messrs Allen, Chamberlain, and Hoy.

The Academy then adjourned to meet in joint session with the State Teachers' Association in the Assembly Chamber. Dr. Chapin delivered an address on the "Nature and Methods of Science, with Thoughts on Teaching Science," before the joint session.

The place to begin teaching science is in the nursery with the child's first efforts at perception. The excellence of the teacher is measured by his ability to inspire enthusiasm. The tools and machinery of the specific branch of science under consideration should be placed in the hands of the student that he may work out for himself the science, aided by hints from his teacher. You cannot pour the conclusions of science into the mind as you would water into a cup.

The time has come when Science is for the masses, and each must rely on his own rational powers. Philosophy has broken the bars of her former seclusion and walks forth in her own native strength and grace, courting the acquaintance and confidence of all, that she may bless all alike, knowing no favorites, except those who draw most largely from her open fountains of truth.

The address finished, the joint session was declared adjourned.

SECOND SESSION.

TUESDAY, December 30, 1879.

The Academy met at 9:30 A. M. in the Senate Chamber.

The following members were elected: Rev. A. A. Young, New Lisbon; F. H. King, River Falls; L. C. Wooster, Whitewater; Prof. H. B. Perkins,

Appleton; Prof. C. W. Butterfield, Madison; Prof. R. C. Hindley, Racine; J. M. Buell, Beloit.

Dr. J. J. Elmendorf of Racine College was elected vice-president for the Department of Letters.

Mr. Hastings submitted the following amendment to the constitution:

To amend section 7 of the constitution by adding to division 1 the following:

The names of annual members who are two years in arrears for dues shall be stricken from the roll of members, unless otherwise recommended by the council.

The following preamble and resolutions were then offered by Mr. Hastings and adopted:

WHEREAS: in consequence of there being no penalty prescribed in either the constitution or the by-laws of the Academy for the non-payment of the annual dues of members, and as no adequate provision has been made for the collection of the same, a very considerable number of the members, doubtless through inadvertency, have become largely indebted to the Academy for dues — the indebtedness amounting in some instances to over forty dollars, an amount so large, that to insist upon its payment, would, without doubt, result in the loss of some of our valuable members, therefore be it

Resolved, That in all cases where members are in arrears to an amount exceeding five dollars, including the amount which will be due on the first day of January, 1880, the treasurer be instructed to balance the accounts, carrying forward to new accounts a balance of five dollars, and that he notify at as early a day as convenient, all persons whose accounts have been so adjusted, informing them that on the receipt of said sum of five dollars they will be clear upon the books to the first day of January, 1881.

Resolved, That hereafter it shall be the duty of the treasurer, within thirty days of the close of each regular annual meeting, to notify all members who are in arrears for annual dues, and also, that he report at each meeting of the Academy the names of all members whose accounts are not square upon his books.

WHEREAS: The general secretary, the librarian and the curator of the Museum have duties to perform in connection with their respective offices for which no compensation is provided; therefore be it

Resolved, That the treasurer be instructed to credit the annual dues of the persons holding the offices above named during the period they discharge the duties of their respective offices.

WHEREAS, Several gentlemen who in former years have been active and useful members of the Academy, have removed from the state and cannot, therefore, be expected to continue the payment of their annual dues, and

WHEREAS, It is desirable that some connection be continued between the Academy and the gentlemen referred to, therefore be it

Resolved, That the following named gentlemen, formerly active members of the Academy, be elected as corresponding members: Rev. G. M. Steele, ex-president, Lawrence University; Rev. Bishop Sam'l Fallows, Chicago; Col. S. V. Shipman, Chicago; Judge J. G. Knapp, Florida; Rev. Chas. Caverno, Lombard, Ill.; Rev. F. M. Holland, Massachusetts.

The following amendment to item 1, section 7 of the constitution, was also submitted by Mr. Hastings:

That the fees of annual members be reduced to one dollar.

Prof. Irving read a paper upon the "Higher Scientific Education," urging that it was of the utmost importance that the teacher of each branch should be a specialist in it, even as to the implanting of the *elementary* ideas.

Adjourned.

THIRD SESSION.

December 30, 2:30 P. M.

The session opened with a paper by Prof. T. C. Chamberlain, on "A New System of Nomenclature in Lithology." [See page 234.] He afterwards lectured in a very interesting manner upon the fossil tracks in the Potsdam Sandstone of Wisconsin. [See page 276.]

Prof. Irving introduced Mr. Magnus Swenson, a student of the University, who read an admirable paper, on "A Syenite from Grand Rapids, Wisconsin," illustrated by a diagram coloured to show the appearance of the Microscopic section of polarized light. This paper was the fruit of much careful original chemical and physical work.

Dr. Hoy read a paper on "Menobranchus Lateralis," illustrated by a specimen. [See page 248.]

A paper on "Miracles in the Light of Modern Science and Philosophy," was read by Dr. J. J. Elmendorf, D. D., of Racine College. [See page 66.]

An able paper on "The Relation of Woman's Suffrage to Society and Domestic Life," was read by Mrs. Olympia Brown Willis, of Racine.

During this session a special session of the Department of Natural Sciences was held at Science Hall, where Prof. R. D. Irving lectured on the "Microscope in Geology," illustrated by the aid of the Calcium light.

Adjourned.

FOURTH SESSION.

December 30, 7:30 P. M.

The Academy met in joint session with the Teacher's Association in the Assembly Chamber, and listened to a most interesting lecture on "The Arts of Engraving and Etching," by Prof. James McAllister, of Milwaukee, illustrated by numerous examples from the great masters.

Adjourned.

FIFTH SESSION.

December 31, 9 P. M.

Academy met in the Senate Chamber.

Routine business transacted.

The following is the programme of papers read:

"On the Economic Principles of the Distribution of Profits," by Prof. A. O. Wright, Fox Lake. [See page 38.]

"Wealth, Capital and Credit," by Prof. J. B. Parkinson, Madison. [See page 46.]

"Food Adulterations," by I. M. Buell, Beloit.

"The English Cottagers in the Middle Ages," by Prof. W. F. Allen, Madison. [See page 1.]

Adjourned.

SIXTH SESSION.

SENATE CHAMBER, December 31, 2 P. M.

Prof. W. W. Daniells made some remarks on the "Recent Results in the Decomposition of the Elements."

Charles I. King of the University followed on the "Practical Value and Analysis of Indicator Diagrams.

Prof. J. D. Butler presented a paper on the "ἅπαξ λεγομενα of Shakespere." [See page 161.]

Adjourned.

SEVENTH SESSION.

December 31, 7:30 P. M.

The academy met in joint session with the Teacher's Association to listen to an exposition of the "Methods of Instruction of the Deaf and Dumb," by W. H. DeMotte, L. L. D., illustrated by class and individual exercises by pupils from the state institute at Delavan.

President Chapin followed with a few remarks, and the meeting adjourned *sine die.*

ELEVENTH REGULAR ANNUAL MEETING,

Held in the Agricultural Rooms of the Capitol, at Madison, December 28, 29 and 30, 1880.

FIRST SESSION.

TUESDAY EVENING, December 28, 7:30, P. M.

In the absence of President Chapin, Prof. R. D. Irving, Vice-president of the Department of Sciences, called the Academy to order.

Prof. J. E. Davies, secretary, read the minutes of the previous meeting. Report accepted after a few minor corrections.

Hon. S. D. Hastings submitted his report as treasurer of the Academy, as follows:

MADISON, December 28, 1880.

Report of the treasurer of the Wisconsin Academy of Science, Arts and Letters for the year 1880:

1879.		
Dec. 30.	Balance on hand as per last report	$617 64
Dec. 30.	Received from L. C. Wooster	5 00
Dec. 30.	Received from Alex. Kerr	5 00
Dec. 30.	Received from Ira M. Buell	5 00
Dec. 30.	Received from A. L. Chapin	5 00
Dec. 30.	Received from S. D. Peet	5 00
Dec. 30.	Received from A. A. Young	5 00
Dec. 31.	Received from T. C. Chamberlin	3 00
Dec. 31.	Received from P. R. Hoy	5 00
Dec. 31.	Received from D. B. Frankenburger	5 00
Dec. 31.	Received from W. F. Allen	4 00
Dec. 31.	Received from W. C. Sawyer	5 00
Dec. 31.	Received from Lucius Heritage	5 00
1880.		
Jan. 8.	Received from J. B. Pradt	5 00
Jan. 8.	Received from W. A. P. Morris	5 00
Jan. 9.	Received from Jas. S. Buck	3 00
Jan. 9.	Received from J. G. Meacham, Sr.	5 00
Jan. 9.	Received from J. G. Meacham, Jr.	5 00
Jan. 9.	Received from E. B. Winship	5 00
Jan. 10.	Received from B. E. Hutchinson	5 00
Jan. 10.	Received from W. E. Smith	5 00

0.

. 10.	Received from J. Emerson	$5 00
. 10.	Received from Thure Kumlien	5 00
. 12.	Received from Mrs. N. H. Adsit	3 00
. 13.	Received from O. M. Conover	11 00
. 13.	Received from Burr W. Jones	5 00
. 13.	Received from W. C. Whitford	5 00
. 13.	Received from H. S. Orton	5 00
. 13.	Received from J. C. Foye	5 00
. 13.	Received from W. P. McLaren	3 00
. 13.	Received from Chas. A. Farrar	5 00
. 13.	Received from M. H. Simmons	5 00
. 13.	Received from Solon Marks	5 00
. 13.	Received from Mrs. Geo. Gordon	3 00
. 23.	Received from H. B. Perkins	5 00
. 23.	Received from Henry Sneiding	5 00
. 23.	Received from Marion V. Dudley	5 00
. 23.	Received from Delaplaine & Burdick, interest	4 23
. 23.	Received from Delaplaine & Burdick, two notes each $500	1,000 00
. 23.	Received from E. W. Bartlett	5 00
. 28.	Received from Henry Beaty	5 00
. 4.	Received from John Bascom	5 00
. 11.	Received from J. J. Elmendorf	5 00
. 12.	Received from F. H. King	5 00
r. 8.	Received from Mrs. Sarah F. Dean	5 00
g. 10.	Received from Mrs. O. B. Willis	3 00
. 7.	Received from F. W. A. Falk	5 00
. 19.	Received from R. D. Irving	5 00
v. 15.	Received from Jas. D. Butler	5 00
. 9.	Received from W. C. Allen	5 00
. 11.	Received from O. S. Wescott	3 00
. 16.	Received from Mary J. Lapham	3 00
. 16.	Received from Mrs D. A. Olin	3 00
. 17.	Received from Geo. Raymer	5 00
. 18.	Received from F. H. Day	3 00
. 27.	Received from L. C. Draper	5 00
. 27.	Received from R. C Hindley	5 00
. 27.	Received from W. W. Daniells	3 00
. 27.	Received from P. Hendrickson	5 00
	Total receipts	$1,882 86

Disbursements.

ayments on the order of the President and Secretary have been made as ows:

).

. 30.	To Henry Mason (current expenses)	$5 00
. 30.	To Henry Mason (clerk hire)	5 00
).		
. 30.	To A. L. Chapin (postage)	1 00
. 5.	To Permanent Fund	1,000 00
. 13.	To E. A. Birge (postage)	2 50
. 18.	To W. J. Park & Co. (binding)	65 25
. 19.	To E. A. Birge (expressage)	1 85
e 7.	To M. J. Cantwell (printing)	12 00
y 2.	To David Mason (expenses)	10 00
. 28.	To Julius Nelson (clerk hire and expenses)	12 20
	Total disbursements	$1,114 80
	uct from receipts above leaves balance on hand Dec. 28, 1880.	768 06

Respectfully submitted,

SAMUEL D. HASTINGS, *Treas.*

The report was referred to the Finance committee, consisting of Prof. W. W. Danells, Hon. Burr Jones and Gen. Geo. Delaplaine.

The paper announced for the evening was not read, owing to the absence of the author, Mrs. Willis.

The Academy then adjourned to listen to the address of Pres. Bascom, of the State University, before the state teachers' association.

SECOND SESSION.

Wednesday, December 29, 9:30 A. M.

Academy called to order by the treasurer, Hon. S. D. Hastings, he being the only officer present. On motion of Prof. W. F. Allen, Dr. P. R. Hoy was elected to the chair, and Prof. A. O. Wright elected secretary *pro tem.*

The report of Prof. E. A. Birge, librarian, was presented by Julius Nelson, acting librarian, and was adopted.

The following resolution was offered by Hon. S. D. Hastings:

WHEREAS, Prof. J. E. Davies and Gen. Geo. P. Delaplaine have rendered some eight years valuable service to the Academy, the first named as general secretary and the other as treasurer, therefore as an acknowledgment of our appreciation of their faithful labors they are hereby elected life members of the Academy.

The resolution was referred to a committee consisting of Hon. S. D. Hastings, Hon. Burr Jones and Prof. T. C. Chamberlin, who were to report on the legality of adopting the resolution.

Prof. Butler read a paper on "The French Pioneers of the Northwest." [See page. 85.]

Discussed by Prof. A. O. Wright, Prof. W. F. Allen and the chair.

Academy adjourned until 2 o'clock.

THIRD SESSION.

December 29, 2 P. M.

Prof. R. D. Irving in the chair.

Several names were proposed for membership and referred to the committee on Nomination.

A paper was presented by Mr. J. C. Arthur, of the University, on "The True Form of Pollen Grains," to which he appended a paper on "The Various Forms of Trichomes of Echinocystis lobata." Both papers were illustrated by drawings. In the first Mr. Arthur contended that in general the observations upon pollen grains are made when these have lost a considerable portion of their moisture and are consequently wrinkled. In the second he showed the many and curious forms which the vegetable cell assumes in the hairs or down upon the leaves, stem and fruit of the plant.

Prof. T. C. Chamberlain, of Beloit, state geologist, gave a lecture illustrated by drawings, on "A New Element in the Preliminary Estimates for Artesian Wells."

The professor held that the water contained freely in the microscopic crevices of rocks would, when these lay above the valley, give a resultant pressure which must be recognized in determining the height to which the water would rise in an Artesian well. Prof. J. E. Davies took exceptions to

this, maintaining that the capillary attraction would neutralize all the downward pressure. The paper was further discussed by Dr. Hoy, Prof. Irving and Prof. Wooster. Prof. A. O. Wright concluded the discussion by calling attention to certain metamorphic rocks in Vernon county not noticed in the State Geological Survey.

Prof. T. C. Chamberlain read a paper on "Recent Pseudomorphic and Chemical Changes in the Minerals of the Lead Region" illustrated by specimens. The paper was discussed by Prof. Daniells.

Prof. Daniells reported for the finance committee that the treasurer's report had been audited and found correct.

Report adopted.

A motion was carried that the treasurer be included with those officers who are relieved from their annual dues.

The nominating committee consisting of Hon. S. D. Hastings and Prof. Alex. Kerr, recommended the following persons as annual members: J. M. Olin, Madison; Dr. U. P. Stair, Black Earth; C. F. Viebahn, Manitowoc.

The above named persons were elected.

The following amendment was carried:

To amend item 1, section 7 of the constitution, so that it shall read as follows:

1st. Annual members who shall pay an initiation fee of two dollars and thereafter an annual fee of one dollar.

The following resolutions were adopted:

WHEREAS, The initiation fee for membership has been reduced to two dollars and the annual dues to one dollar, therefore

Resolved, (1) That any person, who in previous years has been elected to membership to the Academy but who has not consummated his or her membership by the payment of the initiation fee, be allowed to do so by the payment of two dollars.

Resolved, (2) That the treasurer be authorized to balance the account of any old member of the Academy to the first day of January, 1882, on the payment of two dollars.

The treasurer was instructed to devise a plan for equalizing the amounts paid by the members as annual dues to conform with the new rules.

Hon. G. H. Paul, vice president, in the absence of the president was requested to make the annual report to the governor of the state.

It was suggested that the letter of the law be more closely adhered to than formerly, viz.: that the report be annual instead of semi-occasional.

FOURTH SESSION.

December 29, 7:30 P. M.

Academy called to order.

Prof. R. D. Irving in the chair.

The Academy listened to a paper by Capt. John Nader, city surveyor of Madison, on the "Tides." The paper was illustrated by numerous drawings and a new co-tidal map. [See page 207.]

FIFTH SESSION.

December 30, 9:30 A. M.

Academy called to order by Dr. J. E. Davies.

On motion of Prof. Butler Dr. Hoy was called to the chair.

Minutes of preceding meeting read and adopted.

The following report of Hon. S. D. Hastings was read and adopted:

The undersigned having been appointed to devise some plan by which the members of the Academy who have been longest in connection therewith and have borne the chief burden of its financial support in the past may be placed somewhat upon an equality with the members now coming into the Academy at the greatly reduced rates for initiation fees and annual dues, would suggest the following:

That the treasurer ascertain the amount paid into the treasury of the Academy by the present members, and also ascertain the amount they would have been required to pay in case the initiation fee and annual dues at the organization of the Academy had been what they now are and then ascertain what each member has paid in excess of what he would have paid had the fees and dues been at the present rate, and that he credit each member on his annual dues for the future one year for each two dollars he has paid in excess as above stated; provided, that in the case of members who are now in arrears in the payment of their annual dues, two dollars shall be deducted from the amount of the excess payment. Respectfully submitted,

S. D. HASTINGS.

A motion was carried to the effect that hereafter the initiation fee be accepted by the treasurer as covering the dues of the new members for the first year.

Hon. O. S. Wescott presented the necessity existing for the appointment of a state entomologist, and introduced the following preamble and resolutions, which were carried:

WHEREAS, The State of Wisconsin suffers annually from the depredations of noxious insects to an extent measured by a loss of not less than fifteen or twenty millions of dollars; and,

WHEREAS, It is the part of the wisest economy to expend money for the prevention, rather than cure; therefore,

Resolved (1), That the Wisconsin Academy of Sciences, Arts and Letters hereby earnestly recommend to the legislature of the state the appointment of some competent scientific person, whose time and service shall be entirely devoted to investigating the insects of the state, and communicating the results of such investigation to the people thereof in the interest of her agriculture, her hortiulture and her forestry.

Resolved (2), That Gen. Geo. E. Bryant, Prof. W. W. Daniells and Hon. S. D. Hastings be requested to act as a committee to take this matter in charge, and secure, if possible, proper legislative action thereon.

To this committee were added Prof. O. S. Wescott and Prof. T. C. Chamberlin.

The secretary and Prof. Wescott were elected a committee to advise with the officers of the State Teacher's Association with regard to joint sessions of that Association and the Academy, or other means of working in common for the advancement of education in the state.

The summer meeting was appointed to be held in Appleton at such a date as would be fixed by correspondence by the secretary.

Prof. A. O. Wright, Prof. J. D. Butler and Prof. J. E. Davies were made a committee on the publication of the proceedings of the Academy.

Dr. Hoy read a paper on the "Hygiene of Drinking Water."

Prof. O. S. Wescott, of Racine, read a paper on the "Orthoëpy and Etymology of Entomological Names."

Discussed by Professors Allen, Wooster, Parkinson and Wescott.

The Academy adjourned *sine die.*

THIRD SEMI-ANNUAL MEETING,

Held at Appleton, Wis., July 5 and 6, 1881.

APPLETON, July 5, 1881.

The Academy met in the College buildings.

In the absence of the president and the vice-presidents, Prof. W. F. Allen was elected president *pro tem.*

In the absence of the secretary, Prof. A. O. Wright was elected secretary *pro tem.*

Prof. Allen and Hon. S. D. Hastings were made a committee on Nominations, to whom were referred several names for membership.

Rev. S. D. Peet of Clinton, delivered an address on "Buffalo Drives among the Mound Builders," which was illustrated by charts.

APPLETON, July 6, 1881.

Academy called to order.

Acting president Prof. Allen in the chair.

The following persons were elected members: Rev. Stephen Bowen, Clinton, Wis.; Wm. Jones, Clinton, Wis.; W. H. Beach, Beloit, Wis.

Prof. A. O. Wright offered the following resolution, which was adopted:

Resolved, That the Publication Committee be authorized to expend a sum not to exceed eighty dollars for engravings for the forthcoming volume of the transactions in addition to the amount allowed by the state.

The following resolution also offered by Prof. Wright, was adopted:

Resolved, That the librarian be authorized to expend one hundred dollars for binding.

Prof. W. C. Sawyer of Appleton, gave an unwritten address upon the "Phonetic Elements of German," which was discussed by Prof. A. O. Wright and Rev. S. D. Peet.

"The Prehistoric Architecture of America" was the title of a paper read by Rev. S. D. Peet of Clinton. [See page 290.] The paper was discussed by Prof. Wright and Prof. Allen.

The Academy adjourned until the afternoon.

The afternoon session was opened by a paper by W. H. Beach on the "Limits of Thought," discussed by Prof. Wright, Prof. Sawyer, Dr. Hoy and Dr. Meacham.

A paper on "Shakespeare as a Cicerone," by Prof. J. D. Butler of Madison, was read in his absence by Prof. A. O. Wright.

Dr. R. Hoy of Racine, followed with a paper on "The Growth of Trees."

The Academy adjourned *sine die.*

LIBRARY CATALOGUE.

REPORT OF LIBRARIAN.

MADISON, December 29, 1881.

To the President of the Wisconsin Academy:

SIR: I have the honor to submit the following report of the state of the library of the Wisconsin Academy of Sciences at date.

Having been left in charge of the library during the absence of Dr. Birge in Europe, it has fallen to me as clerk of the Academy to prepare a list of the additions to the library since the publication of Vol. IV.

Vol. IV contains a catalogue of the library, but owing to the increase of the library and to the errors, omissions and other faults of this catalogue naturally accompanying a first attempt to bring order out of the chaos of publication in various languages which had accumulated, it was not found a practical guide to the librarian in the distribution of our own publications.

Moreover, many publications had made their way upon the shelves without the knowledge of the librarian, so it became necessary to recatalogue the library. In connection with this work, the publications themselves have been classified and arranged so far as our limited accommodations would admit.

The use of the catalogue to the librarian has been made the primary aim in its preparation. For this reason there remain considerable possibilities of improvement in other directions; but to have made these would have required more labor than could profitably be expended at this time. When the library shall have grown to be the repository of the leading scientific memories of contemporary progress, and our specialists who are able to read all the modern European languages, more numerous, then a catalogue which can be used as a subject-index, will be in order.

That the library may increase healthily, it is essential that the librarian or his clerk, first, receive *all* the gifts sent to the Academy; secondly, that he keep a *journal* of such donations; and thirdly, that he *acknowledge* their receipt. These three points really govern the methods which may be used by the acting librarian, the importance of which can be fully appreciated only by one who has attempted to fulfil the duties of this office. These points have been neglected in a measure and the consequences have been three fold. First, we receive but one-half as much matter as could be received; secondly, many parts which have been sent us are not now upon our shelves. Wherever I could obtain direct knowledge of such fact, the catalogue has been made to include such parts, out of simple justice to the donors. It may be taken

as a general rule that where a series is tolerably complete as seen from the catalogue, all was at some time sent us; and thirdly, many societies entitled to them, lack our transactions in whole or in part.

To give an idea of the size of our library which began but ten years ago, I will state that it *crowds* about 100 feet of shelving.

All complete volumes are either bound and labelled or are in process of binding.

The catalogue includes no publications received later than Jan. 1, 1882, at which time new officers, including librarian, had entered upon their duties.

Foreign exchanges are effected through the mediation of the Smithsonian Institution, Washington, D. C.

It is customary with most foreign societies to send with each donation a printed notice and a blank form for acknowledgment, to be returned to the donor signed. I would recommend that with the donations made in connection with this volume, we have something similar printed which shall contain a list of our publications, from which all those parts received by the societies may be checked off. The returned slip will enable us to give said societies its lacking volumes. In this connection, we might also send list of parts lacking in our library to the society concerned.

Respectfully submitted,

JULIUS NELSON, *Clerk for*
E. A. BIRGE, *Librarian.*

PUBLICATIONS OF LEARNED SOCIETIES NOW IN THE LIBRARY OF THE ACADEMY.

DENMARK.

KJÖBENHAVN —

Det kongelige danske Videnskabernes Selskab.

Oversigt over Forhandlingerne, 1874 to 1881. Bul. Soc. danois de la Copenhagne, '76; 1 and 2, '77; 1.

NORWAY.

KRISTIANIA —

K. Norske Videnskabs Selskab og Frederiks Universitet.

Die Culturpflanzen Norwegens — Schübeler, program, Ist Semester, '62.

Remarkable Forms of Deep Sea Life — M. & G. O. Sars, Ist Semest., '69.

Recherches Chronologie Egyptienne — Lieblein, Ist Sem., '72.

Skuringsmaerker — Kjerulf, II Sem., '72.

Egyptischen Denkmaler — Lieblein, I Sem., '74.

Gründtraekkene i den Aeldste Norske Process — Hertzberg, I Sem., '74.

KRISTIANA — continued.

Enumeratio Insectorum Norvegicorum, I to IV; Siebke, Ist Sem., '74 to '77.

Transfusion u. Plethora — Müller, I Sem., '75.

Rem. Forms Animal Life, No. 2, Brisinga,— G. O. Sars, IId S. '75.

Pflanzenwelt Norwegens — Schübbeler, IInd Sem., '75.

Windrosen Südlichen Norwegens —Seue, Ist Sem., '76.

Etudes les Mouvements de l'Atmosphere — I, Guldberg & Mohn, IInd Sem., '76.

Poncelet's Betydning for Geometrien — Holst, I Sem., '79.

Beretning om nogle landbrugschemiske Undersögelser ved Aas höiere Landbrugsskole — Rosing, 1870.

Det Norske Landbrugs Historje, 1815 to 1870 — Smitt, '76.

Stratifikationens Spor — Kjerulf, 1877.

RuneIndskriften paa Ringen i Forsa Kirke — Bugge, '77.

Department for det Indre.

Aarberetning, Landbrugets Fremme, 1875.

Indberetninger, 1858, 1864.

Norges Officielle Statistic, No. 6. Landbrugskolen i Aas, 1868–70.

Beretning om Landbrugskolen i Aas, 1870–71.

Beretning om Landbrugskolen i Aas, 1871–2.

Beretning om Landbrugskolen i Aas, 1874–5.

Polyteknisk Tidskrift —Törkehus for Korn — Dahl, 1867.

Rugekasser for smaafugle — Collett, 1870.

Beretning fra Agronom — T. Wiel, 1855.

Les Peches de la Norwege — Baars, Expos. Univ. Paris, 1867.

Beretning om Ladegaardsoens Hovedgaard, '62–3.

Anden Beretning om Ladegaardsoens Hovedgaard, I, 72; II, 75.

Meteorologiske Institut.

Norges Vind og Storm Statistik — Prof. H. Mohn, 1869.

Den Norske Nordhavsexpedition, 1876–78. (Editorial Committee for.)

Chemi, Tornöe.

Zoologi, Fiske, Collett.

Gephyrea, Danielssen og Koren.

SWEDEN.

STOCKHOLM —

K. Svenska Vetanskaps Akademi.

Öfversigt öfver Forhandlingarne, XXXIII, 1876.

Bihang til Handlingarne, III, '76.

Handlingar, XI, '72; XIII, '75; XIV, part 1, '75.

UPSALA —

K. Svenska Vetanskaps Academi.

Handlingar, II, '70. Plates XI, '72; XIII, '74; XIV, '75.

Nova Acta Reg. Soc. Scientiarum, IX, '74–5; XI, '76; II, '79.

Nova Acta Reg. Soc. Scientiarum, Volumen extra, 1877.

UPSALA — continued.

L. 'Observatoire de l'Universite d'Upsal.

Bulletin IV-VII, '72-75; VIII, '76; IX, '77.

RUSSIA.

HELSINGFORS —

Finska Vetenskaps Societat.

Forhandlingar, '70-71.

Öfversigt, XIV, 71, '72.

" Natur och Folk," XVII, XVIII, XIX, XXI, XXII, XXIII, XXIV, XXXII.

Finland's Officiela Statistik, V, 1, 1846-65.

Acta Societatis Scientiarum Fennicae, IX, X, XI.

Observationes magnetiques et meteorologique de soc. des sciences de Finlande, V, '73.

Observationes Meteorologique, 1873, 1878.

Gedächtnissrede auf Alex. Nordman, '67.

ST. PETERSBURG —

K. Akademie der Wissenschaften.

Journey to Turkestan, XI, 4.

Recherches Zoographique, II, 5.

Annalen des Physikalisches Central-Observatoriums, 1874, 75, 76, 77, 78, I, II, '79, I, II.

Repertorium für Meteorologie. H. Wild, 1874; I, '75; II, '76; III, '77; IV, 1 and supp. 2, '78; V, 1 and 2, '79; VI, 1 and 2, '80; VII, 1, and supplement in two parts, " Die Temperatur Verhältnisse des Russisch. Reichs," with Atlas, 1879.

Acta Horti Petropolitani (K. Botanischer Garten.)

I to VII each in 2 parts (Supplem. to III, 2), 1871-80.

K. Freie Okonomische Gesellschaft.

Mittheilungen, '55, 2-6; '56, 1-5; '57, 1, 2, 4-6: '58, 1, 2, 4-6; '59, 1-4, 6; '60, 4, 6; '61, 1-6; '63, 1, 3-6.

AUSTRO-HUNGARIAN EMPIRE.

AGRAM —

Akademie der Wissenschaften u. Kunsten.

Abhandlungen, XXVIII, '74.

BRÜNN —

Naturforschender Verein.

Katalog der Bibliothek.

Verhandlungen, XII to XIV, '73-5; XVII, XVIII, '78, '79.

PRAG —

K. Bohmische Gesellschaft der Wissenschaft.

Sitzungsbericht, '79, '80.

Jahresbericht, '78, '80.

Cat. des fossiles Siluriennes (Soc. de Boheme).

PRAG —

Joachim Barrande.

Cephalopodes, II, '77.

Brachiopodes, V, '79.

Defense des Colonies, V, '81.

WIEN —

K. Akad. der Wissenschaften.

Sitzungsberichte, Math. Naturw. Classe.

I. Abtheilung: mineral., bot., zool., geol., paleont.

II. Abtheilung: math., phys., chem., mech., meteor., astron.

III. Abtheilung: physiol., anatn., medicin.

Band, LX; LXI: *Abth.*, *I*, *II;* LXII: *I*, 1–3, *II*, 1–3; LXVI: *I*, *II*, *III;* LXVII: *I* to *III;* LXVIII: *I;* LXIX: *I*, *II;* LXX: *I*, 1–5, *II*, 1–5, *III*, 1–5; LXXI: *I*, *II*, *III;* LXXIX: *III;* LXXV: *I*, *II;* LXXVI: *II;* LXXIX: *I*, 1–5, *II*, 4–5; LXXX: *I*, 1–5, *II*, 1–5, *III*, 1–5; LXXXI: *I*, 1–3, *II*, 1–3 — '69 to '80.

Register, '51–'60.

Anzeiger, 1875 to 1881 each, XXVI to XXIX parts.

Misc.: Catalogue livres de fonds sciences medicinales, '67.

Austria at the International Exhibition — Arenstein.

Urtheile über Gremers Schreibhefte für Volkschulen.

K. Zoologisch-Botanische Gesellschaft.

Verhandlungen, XX to XXX, '70–'80, except XXI, XXII.

K. K. Geologisch-Reichsanstalt.

(Institut Geologique D'Autriche.) Exposition universelle de Paris, 1867.

K. K. Landwirthschaft. Gesellschaft.

Verhand. V, 1, 2; VI, 1, 2. '55, '56.

GERMANY.

BONN —

Naturhistorischer Verein der Preussischen Rheinlande und Westfalens.

Verhandlungen XXVII, 1870, 1 and 2; XXIX, 2; XXX to XXXVIII, 1 and Sup. 1881.

Niederrheinische Gesellschaft fur Natur u. Heilkunde.

Sitzungsbericht, 1876, pp. 80 to 225 missing.

Westfalens Correspondenzblatt. No. 1, '77.

BRAUNSCHWEIG —

Verein fur Wissenschaften.

Jahresbericht, '79, '80.

BREMEN —

Naturwissenschaftlicher Verein.

Abhandlungen III, '73, 8te Jahresb.; IV, 74, 75; V, '76 to '78, parts 1–4; VI, 1 to 3, 1880; VII, 1, 2, '81.

Beilage, Nos. 2–8, '71 to '79.

BRESLAU —

Schlessische Gesellschaft fur Vaterlandische Cultur.

Jahresbericht, LI to LVIII, '73 to '88.

Abhandlungen, '73–4. Register 1804–76.

Fortsetzung der Verzeichnisse.

DANZIG —

Naturforschende Gesellschaft.

Schriften, 1871, II 3, to '81, V 2, exc. 73, III 1.

DRESDEN —

"Isis." Naturwissenschaftliche Gesellschaft.

Sitzungsberichte, '74, Apr.–Sept.; '75, Jan.–Jun., Jul.–Dec.; '76, Jul.–Dec.; '77, Jan.–Mar.; '78, Jan.–Jul.; 79, Jul.–Dec.; '80, Jan.–Jul., Jul.–Dec.; '81, Jan.–Jun.

Diekau, "Die Kaukasusländer." Schneider.

K. Blinden Anstalt.

Jahresbericht, 1859.

K. Deutsche Leopoldinisch-Carolinische Akademie der Naturforscher.

Abhandlungen, 1876.

ELDENA —

K. Akademie der Wissenschaften.

Katalog der Universität Greifswald, 1870.

EMDEN —

Naturforschende Gesellschaft.

Jahresbericht, 56 to 65, 1870 to '80.

Kleine Schriften, XV to XVIII.

FRANKFURT —

Aertztlicher Verein.

Jahresbericht, XXII, 1878.

FRANKFURT A. M. —

Naturforschende Gesellschaft.

Jahresbericht, VI, 1, '77–'8; 2, '79–'80.

FREIBURG —

Naturforschende Gesellschaft.

Bericht über Verhand., VI, 1 and 4, '74–'76.

GIESSEN —

Oberhessiche Gesellschaft fur Natur u. Heilkunde.

Bericht, XV to XX, 1876 to '81.

GÖTTINGEN —

K. Gesellschaft der Wissenschaft und Georg-Augusts Universitat.

Nachrichten, 1877 to '81.

GÖRLITZ —

Naturhistoriche Gesellschaft.

Abhandlungen, XV to XVII, '75 to '81.

HALLE —

Zeitschrift der Gesammten Naturwissenschaften der Universitat, C. G. Giebel, Redaktor.

1874: IX, 1-6; X, 7-12; '75: XI, XII; '76: XIII, XIV; '78, 2-9; '79, 1-6; '80, 3-6.

HANOVER —

Polytechnische Hochschule.

Program, 1873 to 1881.

HEIDELBERG —

Naturhistorischer u. Medicicinischer Verein.

Verhandlungen, Neue Folge, I: 1, 2, 3, 5; II: 3, 4; III: 1874-'81.

JENA —

Gesellschaft fur Medicin u. Naturwissenschaften.

Jenaische Zeitschrift, X, 1876.

Denkschriften, II, 1, 2, 1878.

KARLSRUHE —

Polytechnische Schule.

Program 1872, '77 to '79.

KIEL —

Schriften der Universitat

1856 to 1881 exc. 1877 and '79; also thirty-one "Dissertations" for 1881.

KÖNIGSBERG —

Physikalisch Okonomische Gesellschaft.

Schriften, 1873; 14th year, I and II abtheilung to 1880, I.

LEIPZIG —

Verein fur Erdkunde.

Mittheilungen 1878, '80. Prospektus Botanisches Centralblatt.

Katalog Deutscher Zeitschriften — Köhler.

MANNHEIM —

Verein fur Naturkunde.

Jahresbericht, XXXVI to XXXIX, 1870 to '74.

METZ —

Academie de Metz.

Bulletin Mensuel, 1871-2, '72-3, etc., to 1875-6.

Tables Generales, 1819, '71.

Societe d'Histoire Naturelle.

Bul. XIII, 1.

MÜNCHEN —

K. Baierische Akademie der physikalischen Wissenschaften.

Sitzungsberichte, '70, 1-2; '74, 1-2; '75, 1-3; '76, 1-3; '77, 1-3; '78, 1-4; '79, 1-4; '80, 1-4; '81, 1-4; '82, 1.

Festreden u. Denkschriften, '70, '73, '74, '75, '77, '78, '80.

K. Sternwarte bei M.

Annalen, XX '74 and XXV.

NÜRNBERG —

Naturhistorische Gesellschaft.

Abhandlungen, 4, '67, VI and VII, '77 and '81.

OBERPFALZ U. REGENSBURG —

Historischer Verein.

Verhandlungen, XXXIV and XXXV, '79, '80.

WIESBADEN —

Naussauischer Verein fur Erdknnde.

Jahrbuch, — C. L. Kirschbaum, XXIX, XXX.

SWITZERLAND.

BASEL —

Naturforschende Gesellschaft.

Verhandlungen, VI 1–4, 1874 to '78.

BERN —

Naturforschende Gesellschaft.

Mittheilungen, 1870–72, 684–711; '73, 827; '73–5, 828–905; '76–7, 924–936; '78, 937–961; '79, 962–978; '80, 979–1003.

Verein der Allgemeinen Schweizerischen Naturforschenden Gesellschaften fur Gesammten Naturwissenschaften.

(Societe Commune Helvetique de Sciences naturelles.)

Verhandlungen u. Denkschriften (memoires).

LI. Reunion at Solothurn, 1868–9.
LVI. Reunion at Schaffhausen, 1872–3.
LVII. Reunion at Chur, 1873–4.
LVIII. Reunion at Andermatt, 1874–5.
LVIX. Reunion at Basel, 1875–6.
LX. Reunion at Bex, 1876–7.
LXI. Reunion at Bern, 1877–8.
LXII. Reunion at St. Gall, 1878–9.
LXIII. Reunion at Brieg, 1879–80.

LAUSANNE —

Societe Vaudoise de sciences naturelles.

Bulletin, No. 77, XIV, 1877; No. 78, XV, 1877; No. 79, XV, 1878; XVI, No. 81, 1879; No. 83, 1880; XVII, 84, 1880.

Soc. Helvetique des sciences naturelles.

Actes, 1877, XII, 1, 80.

NEUCHATEL —

Societe histoire des sciences naturelles.

Bul, 1874, '75, '76, '77, '78, '79: X, 1 to 4, XI, 1, 2.

ST. GALL —

Naturwissenschaftliche Gesellschaft.

Bericht über Thätigkeiten, '74–5, '76–7, '77–8.

Naturforschende Gesellschaft.

Vierteljahresschrift, XII, '67; XIII, '68; XVII to XXV, 1880.

Misc.: Souvenir l'Amphiorama, 1880.

Trafford, Notice sur Toilette Nationelle, 1879, Lambuc.

FRANCE.

AMIENS—

Societe Linneenne du Nord de la France.

Memoires, IV, '74–'77.

Bulletin Mensuel, No. 31 to 98; 1871 to 1881.

BORDEAUX—

Academie national de B.

Actes, 1872, 1873.

Acad. Imperiale des sciences, Lettres et Arts.

Actes, 3d series, XXIX, 1867; 3rd Trimestre.

CAEN—

Academie national de C.

Memoires I to VIII, 1788 to '77; except IV, '73.

DIJON—

Acad. des Sciences, Arts et Belles Lettres.

Memoires IV to VI, 1877 to '80.

LYONS—

Acad. des sciences de L.

Memoires, Lettres, XV and XVI, 1870–'75; XVIII, '78–'9; XIX, '79–'80.

Memoires, Sciences, XVIII to XXIV, 1870 to 1880.

LE MANS—

Soc. d'Agriculture Sciences, Arts et Lettres de la Sarthe.

XIII, 1–4; XIV, 1 to 4; XV, 2–4; XVI, 1–4; XVII, 1, 2 and Sup., 3. 4 and Sup.; XVIII, 1–4 and Sup.; XIX, 1, 2 and Sup. XX, 2. 1871 to '82.

MONTPELLIER—

Acad. des Sciences et Lettres.

Memoires, Science, VI, '64–'66; VII, '67–'71; VIII, '72–'75; IX, 76–'80.

Memoires, Medicin, IV 3, '66 to V 2, '79.

l'Histoire de Kyster d'ovaries.

PARIS—

l'Indicateur de l'Archaeologie. No. 13, 1874.

M. Richard. Conformation du cheval.

Leopold Hugo. Les Crystalloides elementaires, 1867.

Les crystalloides a directrice circulaire, '66.

Les crystalloides complexes, '72.

Essai sur la geometrie des crystalloides, '73.

Introduction a la geometrie descriptive des crystalloides, '74.

l'Equidmoide et crystalloides geometriques, 1875.

La Valhalla des sciences pures et appliques, '75.

Astronomie geometrique, '76.

La theorie Hugodecimales, '77.

Ministere de l'Instruction publique. Catalogue, I, II, III.

Rouen —

Soc. d'Amis des sciences naturelles.

Bul. 1879. 15th year, 2d ser., 1st semestre.

BELGIUM.

Bruxelles —

Acad. Royale des sciences et des beaux arts de Belgique.

Principles de l'everage des animaux domestiques, '74.

Fragmentes paleontologiques de Belgiques — Crepin.

Quelques plantes fossiles, 1875 — Crepin.

Notes sur les Pecopteres Odontopteroides.

Notes sur Coccyzus, 1875.

Liege —

Societe Royale des sciences.

Memoires VII, '77; VIII, ' 78; IX, '81.

Soc. Geologique des Belgique.

Annales, Tomes, I to III, 1874–'6.

Mons —

Soc. Sciences, Arts et Letters du Hainaut.

Memoires, IIId Ser., IV, VIII, X, 1870 to 1881.

Memoires, IV Ser., I to V.

Program, 1879, 1881.

THE NETHERLANDS.

Amsterdam —

Koninklijke Akademie van Wetenschappen.

Verslagen, Naturkunde I to XV, 1866 to 1880.

Verslagen, Letterkunde IV, 1874.

Verhand. Naturkunde XIV to XVI, '74 to '76.

Verhand. Letterkunde VIII, X, '75–'76.

Jahrbœk, 1873 to 1875.

Proces Verbal, Naturkunde, '73–4, '74–5, '75-6.

Catalogus I, III, 1.

Roy. Acad. of Netherlands:

"Musa," '74.

"Carmina Latina," '75.

"Hollandia," '76.

K. Zoologisch Genootschap "Natura Artis Magistra."

Catalogus van het Bibliothek, '81.

"Linnæana" Zentoongesteld, January 10, 1878.

Rede ter Herdenking van Carolus Linnæus, '78, Oudimaus.

Opening Splechtigheid van de Zentoonstelling, I to IX, '68–'76.

Anwijzningen Zentoonstelling, 1878.

Plechtige Herdenking van Linnæus Leven en Werken, 1878.

HARLEM —

Nederlandsch Maatschappij ter befordering van Niverheid.

Tijdschrift van Niverheid, 1873 to 1880.

Handeling en Mededeelingen, '73, 2, 3; '74 to '76.

Handeling Algemeene Vergadering Niverheid's Congress, No. 19 to 20, 1873, '75, '76.

Handeling voor Cultuur der Zijderupsen, Fock, 73.

Address a sa majestè le Roi.

Naamlijst der Leden. '77.

Beilage — Kolonidal Museum. II, '75.

Musee Teyler.

Archives, Ser. 1, I, II, III, IV; 1 V, 10, Ser. II; I, 1881.

Hollandsche Maatschappij dpr Wetenschappen.

(Societe Neerlandaises des Sciences exactes et Nat.)

Archives XII to XV, '77 to '80.

Memoire: Telemeteorographe d'Ollande.

LEIDEN —

D. Bierens de Haan.

Notice sur des tables logarithmiques Hollandaises, '73.

Un pamphlet mathematique Hollandaise, '78.

Quelques, quadrateurs du cercle, '74.

Dert Semeijins, '72.

Over der Magt van het zogenaamd onbestaanbare in de Wiskunde.

Differential vergelijkingen, uit eene aangenomen Integral Vergelijkingen, '78.

Boustoffen voor de Geschiedenis der wis-en — Naturkundige Wetenschappen in de Nederlanden, 1878. Sup. to Verh., K. Ak. Wet. Amsterdam, VIII, IX, X and XII.

ROTTERDAM —

Betaafsch Genootschap der Proefondervindelijke Wijsbergeerte.

(Soc. Batave de Philosophie experimentale.)

Nieue Virhad. Reek, II; Deel, II; Stuk, II.

Program 1880.

UTRECHT —

Provinciaal Utrechtschen Genootschap Van Kunsten en Wetenschappen.

Aanteekenningen, II, III, IV, V, 1871 to '76.

Spectatoriale Geschriften, 1741-1800.

Invloed het Klooster Windesheim, I, II, '75, '76.

K. Nederlandsch Meteorologische Instituut.

Jahrboek, '70, II; '71, II; '75, I.

ITALY.

CAGNOLA —

Fondazione Scientifica.

Atti, V, 1, '67-9; VI, 1, '72.

FIRENZE —

Biblioteca Nazionale, Reale Instituto di studj superiori practici e di perfezionamento.

Publicazioni. *Sezzione di filosofia e filologia*, I, '75; II, 1 to 6, 1876 and '77.

Accademia Orientale, 1, '77, and Memoria del Sabbatai Donnola publicato da D. Castelli, 1880.

Sez. Med. e Chirurgia, '76, I, II, 6, and Mem. del dott. Pacini sul Colera Asiatico, 1880.

Mem. del dott. Grassi sul Clinica Ostetrica, '80.

Mem. del dott. Parlatore, and Plates, '81.

Sez. Scienza fisiche e Naturali, Mem. del dott. Cavanna — "Picnogonida."

Sez. Anatomia e biologia, I, '77.

Mem. del. Tavole, Anat. delle piante aquatische, '81.

MILAN —

R. Institnto Lombardo di Scienza Lettere ed Arti.

Rendiconti, II, 69, 17-21; III, IV, 1-13, V, 6-20; VII, VIII, XI, XIII, 1880.

Memoria XI, 2, 3; XII, 2, 6; XIII, 1, 2; XIV, XV.

Recenti studj di Chirurgica Organica — Gabba, 1870.

Accademia fisio-medico-statistica.

Monumento al Cavaliere — Sacco, '58.

Sommario storico della compagne sulla Vinificazione — Dini.

Transfusione del Sangue — Polli, '52.

MODENA —

R. Accad. di scienza lettere ed arti.

Memorie, XVI to XIX, '76 to '79.

Soc. dei naturalisti.

Annusario, XII, 1, 2 and 3.

ROMA —

Real Comitato Geologico d'Italia.

Bollettino, VI to XI, 1875 to 1880.

SPAIN AND PORTUGAL.

LISBON —

Acad. R. de Ciencias de Lisboa.

Sessao publica, 1875, 1877.

Memoria a epiocnomia, 1855.

"solre o estudo industrial e chimico dos trigos Portuguezes."

Alvarenja Lapa.

Technologia rural, '74.

Chimica agricola, '73.

Maladies du coeur.

MADRID —

Sociedad d'Historia naturalia.

Manual.

R. academia d'Historia.

Boletin, I, 5, 1879.

Catalogue portraits anciens de personages illustres.

SOUTH AMERICA.

CARACCAS —

Gaceta cientifica de Venezuela.

I, 5 to 11; II, 1 to 9; 1877-8.

BUENOS AYRES —

Napp.

" Argentine Bepublic."

Anales oficina meteorologica Argentina.

I, '78.

RIO DE JANEIRO —

Brazilian Biographical Annual.

I, II, III.

MEXICO.

MEXICO —

Museo nacional.

Anales, I, 77, 6, 7; II, 1 to 6, 1881.

Sociedad de geografia y'estadistica.

Boletin, IV, 1 to 9; V, 1 to 6; 1878 to '81.

ASIA.

BATAVIA, EAST INDIES —

K. Naturkundge Vereeniging in Nederlandsch Indie.

Tijdscrift, XXXV to XXXIX, 1875 to 1879.

AFRICA.

ISLAND OF MAURITIUS —

Roy. Soc. of Arts and Sciences.

Transactions, IX, '76.

Proces verbaux, 1874.

AUSTRALIA.

MELBOURNE —

Public Library.

SYDNEY —

Dept. of Mines, New South Wales.

Mineral statistics, 1873, 1875.

Mineral map and statistics.

Progress and Resources of N. S. W.

Report for 1875.

Statistical sketch of South Australia, '76.

MAP OF VICTORIA —

GREAT BRITAIN AND IRELAND.

LONDON —

Royal Society.

Proceedings, XXXII, Nos. 153 to 213, except 200.

Transactions, Vol. 165, part IV, memoir XI, Arctic Tides.

Transactions, Vol. 166, part I, memoir IV, Alcyonaria.

Journal of Applied Science, VII.

Roy. Horticultural Soc. Journal, New series, IV, 13, 14, 16.

Geological Society.

Quarterly Journal of, XXXV, 137, 138, 140.

List of Society Members, 1879.

Royal Institution of Great Britain.

Animal Mechanics, Houghton, 1871.

Ashmolean Society.

Beneficent Distribution of Sense of Pain, Rowell, 1862.

Trubner's Literary Record, 1879, 135-7, 155-6.

Bernard Quaritch. Catalogues.

Photographs in Brit. Museum.

English Literature.

Transactions of Learned Societies.

Natural History, Works on.

Clearance Sale, '79.

French, German and Italian Literature.

Antiquities.

Works on Fine Arts.

Works on North and South America.

Rare works in Private Libraries.

Works on Games.

Periodical Litetature.

Misc. Pub. and Remainders.

Bath and West England Soc. Agriculture.

Journal, Third series, 1873.

Quarterly Journal of Conchology. I, 1-15, '76-7.

MANCHESTER —

Literary and Philos. Society.

Catalogue of Library, 1875.

Proceedings, XII to XIX, '73 to '80.

Memoirs, XXV, XXVI, Old Series, '76, '79.

Scientific Students' Association.

Annual Report, '73.

NEWCASTLE ON TYNE —

North of England Institute of Mech. and Min. Engineers.

Index to Transactions, I-XXV, 52-76.

EDINBURGH —

Royal Society of.

Proceedings, 1871 to 1880.

New Phil. Journal.

Mem. by G. A. Rowell, 1881.

Cause of storms and Tererstrial Magnetism.

DUBLIN —

Royal Society.

Scientific Transactions, vol. I, new ser. 1–14.

Scientific Transactions, vol. II, new ser. 1–3.

Journal, I, II, IV, V, XII, XIII, XVI, XXVII, XXIX, XXX, XXXI, XXXIV, to XXXVII, XXXIX, and XLIV.

Cunningham Memoirs, I, '80.

Scientific Proceedings, new ser,, I 1–3, II 1–7.

Royal Irish Academy.

Proceedings, Science, and Minutes, ser. 2, I 13, II 1, III 1–6.

Transactions — Antiquities, XXIV 9, 74.

Polite Literature and Antiquities, XXVII 1–4, '77–'81

Science, XXV, XXVI 1–16, 22.

Irish MS. Series, I 1. Calendar of Oengus — Stokes.

Trustees of late James Henry.

Voyage of discovery in Virgil's Aeneis, I, II, IV.

CANADA.

MONTREAL —

Canadian Antiquarian and Numismatic Society.

Journal, VII 1, Jul. '78.

G. M. Dawson.

Report on Lignite Formation near 40th paral, '73.

TORONTO —

Canadian Institute.

Journal of Proceedings, new ser., I 1, 2, 1879.

OTTAWA —

Royal Society of Canada.

Circular of Incorporation, etc., 1882.

ST. JOHNS —

Rep. of Geolog. Survey of Newfoundland, 1873.

UNITED STATES.

ALBANY, N. Y.—

Regents of State University.

Report No. 85 to 91. 1872 to 1878.

Report on Museum of Natural History, No. 20 to 30, exc. 28. 1866 to 1876.

ALBANY, N. Y.—continued.
Trustees of State Library.
Report No. 54 to 61. 1872 to '79.
Dudley Observatory. Annals, II, 71.
Commission of Fisheries. Report, '73, '74.
Agricultural Society. 1869.
Statutes Relating to Albany County Penitentiary.
Report on Water Supply of Albany.
Report on Topographical Survey Adirondacks. 1873.
Albany Institute—publications.
Hudson's Sailing directions—De Costa, '69.
Maxims of Laws of England, '70.
Fungi. Peck, '70.
The Palatine Emigration, '71.
New Phenomena in Chemistry, '72.
Manual, '75.
Isthmus of Tehuautepec. Skeel.
Biographical notice of Peter Wraxall.

ATCO, N. Y.—
Science Society.
Science Advocate, I, 1-4; II, 1-3; '80, '81.

AUGUSTA, ME.—
Maine Pomological Society. 1st. Ann. Rep., '73.
Natural History and Geology of Maine. 1863.
Hydrographic Survey, Rep.
Water power of Maine. Wells, 1869.
Ornamental and Useful Plants of Maine. 1875.
Cattle of Maine, Boardman.

BOSTON, MASS.—
Soc. of Natural History.
Proceedings XVII to XXI, 2; 1874 to 18881, except XIX, 3.
American Academy of Arts and Sciences.
Proceedings, II, '75; V, 1, 2, '77, '78; VII, 1, 2, '79 to '81.
Memoires, XI, 1, 1882.
Boston Journal of Chemistry. VIII, 2, Aug., 73; IX to XI, 1, 2; XII, 1-11 (exc. 2) 17, Nov., '78; XIII 1, Jan., '79, 3, 4, 8, 9; XIV, 1-12 (exc. 2, 3, 6, 9, 11); XV, 1-12 (exc. 2, 7, 9, 10, 11); XVI, 1-5, May, '82.

BRIDGEPORT, CONN—
Bridgeport Scientific Society.
President's address, 1881.

BUFFALO, N. Y—
Society of Natural Science.
Bul. I, 2, '73, 4, '74; II, 1, '74, 4, 74.

CAMBRIDGE, MASS —

Museum of Comparative Zoology — Harvard University.

Annual Report, '74, '75, '78-9, '80, '81.

Bul. III, '76, 11-16; IV and Plates for III and V of Terrestial Molluscs — Binney. V, 11-16; VI, 3-9; VI, VIII, pp. 1-284; IX, 1-5, 1881.

Memoires, II 9, 1876, Insect Deformities — Hagen.

Memoires, IV, 10, American Bisons — Allen.

Memoires, VII, 1, Florida Reefs — Agassiz.

Memoires, VIII, 1, Immature State of Odonata pt., II — Cabot.

Nuttall Ornithological Club.

Bul., IV, 1, '71.

CHICAGO, ILL —

Academy of Sciences.

Constitution, etc., and Vol. 1, Proceedings, 1865.

Annual Address, 1878.

Public Library. Rep. V, 77; VII, '79.

American Antiquarian and Oriental Journal. IV, 2, '82 — S. D. Peet.

United States Medical Investigator. June, 1873 to April, '76; Nos. 109 to 164 (except 110, 111, 117, 130, 132, 133, 135, 141, 143, 144, 150, 160, 162).

Engineering News. III, 19, 31, 53.

S. W. Burnham. Double Star Observations.

Catalogue of, 1877, 1879.

CINCINNATI, O —

Society of Natural History.

Journal, I, 4, '79; II, 1, 79, 4, '80; III, 1-4; IV, 1, 2, 4.

CLEVELAND, O —

Academy of Natural Science.

Prodeedings, '45 to '59.

COLUMBUS, O —

Geological Survey of Ohio. — N. H. Winchell, 1871.

Surface Geography of Northwestern Ohio, 1872.

DAVENPORT, IA. —

Academy of Natural Science.

Proceedings II 1, '76-7 and Plates.

DES MOINES, IA. —

"The Analyst" J. E Hendricks.

I, 1874 in 12 Nos., II to IX 3 (Exc. VIII 1 and IX 2), ea., 6 Nos.

INDIANAPOLIS, IND. —

State Geological Survey, Cox, Rep., 1869, 1870.

IOWA CITY, IA. —

Iowa Acad. of Natural Science.

Proceedings, 1875 to 1880.

KANSAS CITY, MO.—
"Western Review of Science and Industry," Theo. S Case.
I, 2 May, '77 to V 12. (Exc. I, 6, 10, 11, 12. II, 4-7, 9. III, 3, 5-8, 12. IV, 2, 5, 12. V, 11.)

KNOXVILLE, TENN.—
State University, Cat., '79-'80.

MADISON, WIS.—
Wisconsin Acad. Sciences, Arts and Letters.
Bul.
Transactions I, '70-'72; II, '73-4; III, '75-6; IV, '76-7; V, '79-'81.
State Agricultural Society. Trans. '69 to '77, Exc.
State Historical Soc. Cat. of Library. I, II, '73 and Sup. I, '75.
State Board Charities and Reform, Rep. VIII, '78; IX, '79.
State Universiiy, Rep. Board Regents, 1874.
State Horticultural Soc. Trans., 1867.
State Supt. of Public Instruction, Rep. Pickard, 1861.
School Laws of Wisconsin — Searing, '73, '77.
R. R. Commissioner, An. Rep. I, '74.
Rep. Sec'y of State, 1877.
Legislative Manual, 1863.
Rep. on London and Paris Exhibitions — Hoyt, 1862, 1867.
Wis. State Medical Society — Trans., 1875.
Wisconsin Geolog. Survey — T. C. Ccamberlin, Beloit, Director; Report III.

MIDDLETOWN, CONN.—
Scientific Association.
Occasional papers, 1, '81.

MILWAUKEE, WIS.—
Naturhistorischer Verein.
Jahresbericht, '76, '79-'80, '80-'81.

MINNEAPOLIS, MINN.—
Regents of University,— *Report*, 1870.
University Almanac, '71.
Annual Report on Geological and Natural History.
Survey — N. H. Winchell, '72, '76 to '80.
N. H. Winchell. Notes on Drift Soils of Minn., '73.
Notes on Drift Soils of the Northwest, '73.
Devonian Limestone of Ohio, 1873.
Inaugural Address of Gov. Davis, 1874.
Minn. Acad of Sciences.
Bull. 1877.

NEW HAVEN, CONN.—
Conn. Acad. of Sciences.
Quartzite Limestone of Great Barrington, Mass.,— Dana.
Glacial and Champlain Eras in N. E.,—J. D. Dana.
Amer. Journal of Science and Arts.

NEW YORK, N. Y.

American Museum of Natural History.

Annual Report XII, 1881.

Rep. of Trustees of Central Park Menagerie, 1879.

Journal of American Chemical Society, I 12, '79.

PHILADELPHIA —

Numismatic and Antiquarian Society.

Report on Operations of Soc., '78–9, '81.

Henry Phillips, Jr.

Early Currency of Maryland, 1865.

Pleasure of Numismatic Science, '66.

Medicine and Astrology, '66.

Notes on Collection of Coins and Medals at Penn. Mus., '79.

Notes on a Denarius of Cæsar, 1880.

Head dresses exhibited on ancient coins, 1881.

American Philosophical Society.

D. G. Brinton.

Grammar of Choctaw lang., 1870.

Grammar of Muskokee lang., 1870.

National Legend of Chahtah-Muskokee Indians, 1870.

Ancient Phonetic Alphabet of Yucatan, 1870.

The Books of Chilan Balam, 1881.

Academy of Natural Science.

Proceedings, '77 to '81 — exc. '78, I III, '79, II.

Zoological Society.

Report of Board of Directors, VII to IX, 1879 to '81.

Naturalist's Leisure Hour and Monthly Bul., II 11, III 1, 4, IV 10.

Polytechnic Review,. I 1, '76.

POUGHKEEPSIE, N. Y. —

Soc. of Natural Science.

Proceedings, '79–'80.

PRINCETON, N. J. —

Museum of Archaeology and Geology.

Report of the Princeton Scientific Expedition, 1877.

SALEM, MASS. —

American Association for Advancement of Science.

Proceedings Nashville meeting, 1877, XXVI.

Proceedings St. Louis meeting, 1878, XXVII.

Proceedings Saratoga meeting, 1879, XXVIII.

Proceedings Boston meeting, 1880, XXIX, 1st part.

Proceedings Boston meeting, 1881, XXIX, 2d part.

Naturalists Agency — S. E. Cassino.

Naturalists Directory, 1878.

ST. LOUIS, MO. —

University Catalogue, '76-7.

American Institute of Mining Engineers.

Lignite Coals of Colorado, Potter, 1878.

Academy of Science.

Transactions, III 1, 2, 4, IV 1, 2, 1873-'81.

Archaeology of Missouri, Pottery — pt. I, 1880.

ST. PAUL, MINN.—

Northwestern Medical and Surgical Journal.

I, 2; II, 1; III, 1, 2, 3, 5. 1870-72.

SAN FRANCISCO, CAL.—

Cal. Acad. of Science.

Proceedings, VI, '75-6.

Report of Trustees of James Lick Observatory.

Univ. of California — *Rob. E. C. Stearns.*

Comments on Marine Shells of Cal.

SOUTH BETHLEHEM, PA.—

Lehigh University.

Register, '79, '80.

SPRINGFIELD, ILL.—

R. R. Commissioner. Rep. '72, '73.

Le Baron. Rep. on Noxious Insects, I, II, '71, '72.

State Horticultural Society. Trans. 1867.

SYRACUSE, N. Y.—

Free Dispensary — E. Van de Warker, M. D.

Sun Stroke and its theory, 1870.

Detection of Criminal Abortion, '71.

Criminal use of Advertising Nostrums, 1873.

Use of Seton in Chronic Affections of Womb.

The Detection of Criminal Abortion and Study of Fœticidal Drugs, 1872.

TOPEKA, KAN.—

Kansas Acad. of Sciences.

Transactions, 1873, 1875, 1876, 1877-8.

Catalogue of Birds of Kansas, 1875.

WASHINGTON, D. C., DEPARTMENT OF INTERIOR —

U. S. Geological and Gegoraphical Survey of the Territories. F. V. Hayden in charge.

Annual Reports of Progress. I to XI, 1867 to 1877.

Miscellaneous Publications. I to XI, except II and V.

Bul. Ser. II, 1, 2, 5, 6; Vol. II, 1, 2, 4; III. 1, 2, 4; IV, 1-4; V, 1-4; VI, 1, 2. Birds of Nevada, W. J. Hoffman. Presented by author.

Preliminary Report of Field Work, '77, '78.

Washington, D. C.— continued.

Catalogue of publications, '74.

U. S. Entomological Commission.

Bul., I, 1st and 2d editions; II, III, V.

Report on Rocky Mt. Locust, I, '77–8; II, '78–9.

Reports of Survey: I. Fossil Vertebrates.
II. Cretaceous Vertebrates.
V. Zoology and Botany.
VI. Cretaceous Flora.
VII. Tertiary Flora.
IX. Cretaceous Tertiary Invertebrates.
X. Geometrid Moths.
XI. N. Amer. Rodentia.

U. S. G. & G. Survey of Rocky Mt. Region, J. W. Powell in charge.

Contributions to N. A. Ethnology, I, III, IV.

Exploration of Colorado, '69 to '72.

Geology of the Uintah Mts., '76.

Geology of the Black Hills of Dakota.

Geology of Henry Mts., '77.

Lands of Arid Region, 79; Ex. Doc. No. 73.

Annual Report, 77.

Report on Method of Survey, 1878.

Exploration of the 40th Parallel, Clarence King in charge.

I, Sys. Geol.; II, Descr. Geol.; VI, Ornith. and Pal.; V, Bot.; VII, Odonthornithes, and Report for 1880.

Indian Bureau.

Report on Indian affairs, 1876.

Survey of Black Hills; Rept on Resources of, 1876; W. P. Jenney in charge.

Patent Office.

Report, '69, I, II, and III.

Census Office.

Report on 9th census, 1870; Compendium and Vital Statistics.

General Land Office.

Report, '70, 71.

Bureau of Education.

Circulars of Information, 3 to 7.

Report of Commissioner, '71. 74, 75.

Special Report on Public Libraries.

Smithsonian Institution.

Collections, VII, X, XI.

Report, '71, '75.

Rep. of Coues on Geomys & Thomomys, 1875.

Synopsis of scientific writings of Herschell — Holden & Hastings.

Bureau of Ethnology.

Washington, D. C.— continued.

Introduction to Study of Sign Language of Indians, Powell, '80.
Introduction to Study of Mortuary Customs of Indians, Yarrow.
National Museum.
Bulletin, 1 to 15.

War Department: Engineering Dept. U. S. A.

Geol. & Geog. Survey west of 100th meridian, Lieut. G. M. Wheeler in charge.

Reports: I. Syst. Geol.
II. Astron. and Hypsometry.
III. Geology.
IV. Paleontology.
V. Zoology.
VI. Botany.
VII. Archaeology.

Signal Service Office.
Daily Weather Charts.

Dept. of Navy — U. S. Naval Observatory.

Washington Astron. Observations, '47, '51, '52, '63, '64.
Results of Astron. Observations, '53–60.
Astron. and Meteorol. Observations, '72 to '77.
Report on Total Eclipse of July 29, 1878.
Report on Total Eclipse of January 11, 1881.
Subject Index of Publications, '45–75; Holden, '79.
Catalogue of Library, 1879, Part I.

Treasury Department — Bureau of Statistics.

Finance Report, '73, '76.
Quarterly Qeports, '75, II; '76, I–IV.
Mineral Resources West of Rocky Mountains, Raymond, '71 and '72.
Commerce and Navigation, '76, I, II.
Special Report on Immigration, '69–70.
Rep. Spec. Sur. l'Immigration, Young.

Dept. of Agriculture.

Report, 1871, 1879.
Report on Cotton Insects, '79.
Report on Commercial Relations, '75.
Special Report No. 17, on Condition of Crops.

Department of State.

Messages and Documents — abridged, '67–8, '76, '77.
Messages and Documents, '68–9, I and II.

Philosophical Society — Constitution of, 1871.

Miscellaneous.

Report on Yellowstone National Park — Morris, '77 and '87.

WASHINGTON, D. C.—continued.

Internatl. Exhib., '76 — Classification and Collection to Illustrate Animal Resources of U. S. — Goode.

Natural History of Kerguelen Islands, II, '76.

Preliminary Rep. on Alaska — H. R., 40, Exec. Doc.

Electoral Count, '76.

Digest of Leading Cases in International Law.

Report of U. S. Observ. of Transit of Venus — Kidder, '74–5.

Johnson's Rep. of International Exhibition at London, 1862.

National Almanac, 1863.

Statistical Atlas of United States — Walker.

WORCESTER, MASS.

Worcester County Free Institute of Industrial Science.

Catalogue, 1876, 1877.

UNCLASSIFIED.

Reports of International Congress d'Anthropologj. Bologne.

Sources di Toretta Monte Catini. Toscane, '67.

Memorial of Increase A. Lapham.

History of Dane County.

Report of Progress in Zoology for 1870. Geo. T. Stevens.

Distributions Geographiques des reptiles au Mexique. Sumichrast, '72.

Classment botanique des plantes alimentaries du Brèsil. Gama, Paris, '67.

Les peches de la Norwege. Baars, Paris, '67.

Notice statistique le Chile. Paris, '67.

L'histoire des Roses. Crepin, Paris, parts III and IV.

Richerche sulla cotenna del sangue. Giovanni Polli.

Peat as fuel. Leavitt, Boston.

Gesetz der Wechselwirkung in Weltall. Lüders, 1870.

Das Polar Licht. Luders, '70. Sauk City, Wisconsin.

Aussiedlungen Normanen in Island, Grönland u. Nord Amerika in 800–1100 A. D. Ulrici.

La vie et les travaux de Walowski, '76–'77.

Nitroglycerine as used in Hoosac Tunnel. Mowbray.

Jaarlijksch Verslag der overijsseliche Vereening tot Ontwikkeling van Provinciale Weltwaart. 1854.

De Aardkunde de, Do. 1845.

Report of London and Paris International Expositions. Hoyt, '69.

"Pharaoh's Daughter," Williams and Norgate. London, 1868, 1874.

Map of Victoria, Australia.

Catalogue of Articles contributed by Cape of Good Hope to Paris exposition, 1867.

Map of Scandinavia.

Proceedings of Conference of Charities. Saratoga, 1877.

American Social Science Association. Circular of organization.

Report of Sunday School Association at Norwich, N. Y., 1872.

The following societies have opened exchanges with the Academy since 1881:

Library Club of Philadelphia.
Torrey Botanical Club, New York City.
American Society of Civil Engineers, New York.
Missouri Historical Soiciety, St. Louis, Mo.
John's Hopkins University, Baltimore, Md.
U. S. Fish Commisson.
Videnskabernes Selskab, Throndhjem, Norway.
Charles B. Cory, Boston.
Museum at Bergen, Norway.
Biological Society, Washington, D. C.
R. W. Shufeldt, Washington, D. C.
North of England Institute of M. & M. Engineers, New Castle on Tyne.
Royal Society of Canada, Toronto.
Constant Branden Vanden, 69 Rue de la Madeleine, Bruxelles, Belgium.

The authors of the various Government and State Reports and of certain Societies are entitled to receive the Transactions of the Academy.

LIST OF MEMBERS OF THE ACADEMY.

LIFE MEMBERS.

Case, J. I., Hon., Racine, Wis.
Dewey, Nelson, Ex-Governor Wisconsin, Cassville, Wis.
Hagerman, J. J., Milwaukee, Wis.
Hill, Jas. L.. Hon., Denver, Colorado.
Hoyt, J. W., Hon., Governor Wyoming Territory, Cheyenne.
Lapham, I. A., Milwaukee. (Deceased.)
Lawler, John, Prairie du Chien, Wis.
Mitchell, J. L., Hon., Milwaukee, Wis.
Paul, G. H., Hon., Milwaukee, Wis.
Thomas, J. E. Hon., Sheboygan Falls, Wis.
Thorpe, J. G., Hon., Eau Claire, Wis.
White, S. A. Hon., Whitewater. (Deceased.)

ANNUAL MEMBERS.

Adsit, N. H., Mrs., 268 Knapp St., Milwaukee, Wis.
Allen. W. C., Hon., Racine, Wis.
Allen, W. F., A. M.. Prof. Latin and History, University of Wisconsin.
Baetz, Henry, Hon., Milwaukee, Wis.
Bartlett, E. W., M. D., Milwaukeee, Wis.
Bascom, John, D. D., LL. D., President University of Wisconsin.
Bashford, R. M., A..M., Madison, Wis.
Bate, A. W., Mrs., 320, Terrace Avenue, Milwaukee, Wis.
Birge, E. A., Ph. D., Prof. Zoology, University of Wisconsin, Madison.
Beach, W. H., Beloit., Wis.
Bryant, Ed. E. Hon., Madison, Wis.
Bowen, Stephen, Rev., Clinton, Wis.
Buck, J. S., M. D., Milwaukee, Wis.
Beaty, Henry, Hon., Milwaukee, Wis.
Buell, I. M., Prof., Taladega College, Taladega, Alabama.
Bull, Storm, Univ. Wis., Madison, Wis.
Bundy, W. F., Prof. Eclectic Medical College, Chicago, Ill.
Butler, J. D., LL. D., Madison, Wis.
Cass, Josiah E., Hon., Eau Claire, Wis.
Chamberlain, T. C., A. M., Prof. Nat. Hist. Beloit College and Director of State Geological Survey, Beloit, Wis.
Chapin, A. L., D. D., Pres. Beloit College, Beloit, Wis

Conover, O. M., A. M., Madison, Wis.
Conover, S. F., Mrs., Madison, Wis.
Daniells, W. W., M. D., Prof. Chemistry, Univ. Wis.
Davies, J. E., A. M., M. D., Prof. Physics, Univ. Wis.
Day, F. H., M. D., Wauwatosa, Wis.
Delaplaine, Geo. P., Madison, Wis.
Doyle, Peter, Hon., Prairie du Chien, Wis.
Draper, L. C., Hon., Cor. Sec. State Historical Soc., Madison, Wis.
Dudley, M. V., Mrs., Milwaukee, Wis.
Durrie, D. S., Librarian State Historical Society Wis.
Elmendorf, J. J., S. T. D., Prof. in Racine College, Racine, Wis.
Emerson, J., Professor of Greek, Beloit College, Beloit, Wis.
Falk, F. W. A., Ph. D., Prof. in Racine Col., Racine, Wis.
Farrar, Chas. A., Pres. Milwaukee College, Milwaukee, Wis.
Foye, J. C., A. M., Prof. Physics, Lawrence Univ., Appleton, Wis.
Frankenburger, D. P., Professor Elocution and Rhetoric, Univ. Wis.
Freeman, J. C., A. M., Prof. English Literature, Univ., Wis.
Gapen, Clark, M. D., Prof. Medical Jurisprudence, University of Wis., Madison, Wis.
Giles, Ella, Miss, City Librarian, Madison, Wis.
Gordon, George, Mrs., Humboldt Ave., Milwaukee, Wis.
Green, Thos., A., Milwaukee, Wis.
Hardy, Albert, Principal High School, Milwaukee, Wis.
Hendrickson, Peter, A. M., Prof. in Beloit Col, Beloit, Wis.
Hastings, S. D., Hon, Madison, Wis.
Hindley, R. C., Prof., Racine College, Racine, Wis.
Holton, E. D., Hon., Milwaukee, Wis.
Heritage, Lucius, Univ. Wis., Madison, Wis.
Hoy, P. R., M. D., Racine, Wis.
Hutchinson, B. E., Hon., Madison, Wis.
Irving, R. D., A. M., M. E., Prof. Geol. and Mining Engineering in University of Wisconsin, Madison, Wis.
Jones, Burr W., Hon., Madison, Wis.
Jones, Wm., Clinton, Wis.
Kerr, Alex., A. M., Prof. Greek, University, Wis.
King, F. H., Prof. Nat. Science, State Normal School, River Falls Wis.
Kumlien, Thure, Busseyville, Wis.
Lapham, Mary J., Miss, Oconomowoc, Wis.
Lewis, H. M., Mrs., Madison, Wis.
Marks, Solon, M. D., Prospect Ave., Milwaukee, Wis.
McLaren, W. P., Milwaukee, Wis.
Meacham, J. G., Sr., M. D., Racine, Wis.
Meacham, J. G., Jr., M. D., Racine, Wis.
Morris, W. A. P., Hon., Madison, Wis.

Nader, John, C. E., Madison, Wis.
Olin, D. A., Mrs., Racine, Wis.
Olin, J. M., Esq., Madison, Wis.
Orton, Harlow S., Judge Supreme Court Wis., Madison, Wis.
Parkinson, J. B., A. M., Prof. Political Economy, University Wis.
Peckham, G. W., Prof. Nat. Science, Milwaukee High School.
Peet. S. D., Rev., editor American Antiquarian, Clinton, Wis.
Perkins, H. B., Prof. Lawrence University, Appleton, Wis.
Pradt, J. B., Rev., Madison, Wis.
Raymer, Geo. Madison, Wis.
Reed, Geo., Hon., Manitowoc, Wis.
Rogers, A. J., Milwaukee, Wis.
Sawyer, W. C., Prof. State Normal School, Oshkosh, Wis.
Smith, W. E., Hon., Governor of Wisconsin.
Simmons, H. M., Rev., Minneapolis, Minn.
Sneiding, Henry, Racine, Wis.
Stair, U. P., M. D., Black Earth, Wis.
Viebahn, C. F., Watertown, Wis.
Westcott, O. S., Chicago, Ill.
Willis, O. B., Mrs., Racine, Wis.
Whitford, W. C., A. M., ex-Supt. Public Instruction of Wisconsin, Milton, Wis.
Winship, E. B., Racine College, Racine, Wis.
Wooster, L. C., Prof. Nat. Sciences, State Normal School, Whitewater, Wis.
Wright, A. O., Sec. State Board of Charities and Reform, Madison, Wis.
Young, A. A., Rev., New Lisbon, Wis.

DECEASED MEMBERS.

Armitage, W. E., Right Rev., Bishop P. E. Church, Milwaukee, Wis.
Carpenter, S. H., LL.D., Prof. English Language, University of Wisconsin, Madison, Wis.
De Koven, J., S. T. D., Warden Racine College, Racine, Wis.
Dudley, Wm., Madison, Wis.
Eaton, J. H., Ph. D., Prof. Chemistry Beloit College, Beloit, Wis.
Engelman, Peter, Director German and English Academy, Milwaukee.
Feuling, J. B., Ph. D. Prof. Philology, University Wisconsin.
Hawley, C. T., Milwaukee, Wis.
Lapham, I. A., LL. D., State Geologist, Milwaukee, Wis.
Little, Thos. H., Supt. Institution for the Blind, Janesville.
McDill, A. S., M. D., Supt. State Hospital for the Insane, Madison, Wis.
Nicodemus, W. J. L., A. M. C. E., Prof. Engineering, Univ. Wis.
White, S. A., Hon., Whitewater, Wis.
Wolcott, E. B. M. D., Surgeon General, Milwaukee, Wis.

CORRESPONDING MEMBERS.

Abbott, C. C., M. D., Trenton, N. Jersey.
Andrews, Edmund, A. M. M. D., Prof. Chicago Medical College, Chicago, Ill.
Barrow, John W., 113 East Seventeenth St., New York City.
Bridge, Norman, M. D., Chicago, Ill.
Benton, J. G., M. D., Philadelphia, Penn.
Buchanan, Joseph, M. D., Louisville, Ky.
Burnham, S. W., F. R. A. S., Chieago, Ill.
Byrness, R. M., M. D., Cincinnati, Ohio.
Carr, E. S., M. D., Supt. Public Instruction, California.
Caverno, Rev. Chas., Lombard, Ill.
Ebener, F., Ph. D., Baltimore, Md.
Fallows, Right Rev. Sam'l, Chicago, Ill.
Gatchell, H. P., M. D., Kenosha, Wis.
Gill, Theo., M. D., Smithsonian Institute, Washington, D. C.
Gilman, D. C., Pres. Johns Hopkins University, Baltimore, M. D.
Harris, W. T., LL. D., Concord, Mass.
Hopkins, F. N., M. D., Baton Rouge, La.
Holland, Rev. F. M., Concord, Mass.
Horr, M. D., Pres. Iowa Institute of Arts and Sciences, Dubuque, Ia.
Hubbell, H. P., Winona, Minn.
Jewell, J. S., A. M., M. D., Prof. Chicago Medical College, Chicago, Ill.
Le Barron, Wm., State Entomologist, Geneva, N. Y.
Marcy, Oliver, LL. D., Prof. Northwestern University, Evanston, Ill.
Morgan, L. H., LL. D., Rochester, Ill.
Newberry, J. S., LL. D., Prof. Columbia College, New York.
Orton, E., A. M., Pres. Antioch College, Yellow Springs, Ohio.
Paine, Alford S. T. D., Hinsdale, Ill.
Swezey, G. D., Prof, Crete, Neb.
Porter, W. B., Prof., St. Louis, Mo.
Safford, T. H., Director Astron. Observatory Williams College, Williamstown, Mass.
De Vere, Schele M., LL.D., Prof. University Virginia, Charlotteville, Va.
Shaler, N. S., A. M., Prof. Harvard University, Cambridge, Mass.
Shipman, Col. S. V., Chicago, Ill.
Steele, Rev. G. M., LL. D., Principal of Wilbraham Seminary, Wilbraham, Mass.
Trumbull, J. H., LL. D., Hartford, Conn.
Verrill, A. E., A. M., Prof. Yale College, New Haven, Conn.
Van de Warker, Eli, M. D., Syracuse, N. Y.
Whitney, W. D., Prof. Yale College, New Haven, Conn.
Winchell, Alex., LL. D., Ann Arbor, Mich.
Winchell, N. H., Prof., Minneapolis, Minn.

HONORARY MEMBERS.

Baird, Spencer F., M. D., LL. D., Washington, D. C,
Hamilton, Joseph, Hon., Milwaukee, Wis.

MEMBERS ELECTED DECEMBER 23, 1881.

Higby, W. R., Prof., Lake Geneva Seminary.
Lamb, F. J., Esq., Madison.
Salisbury, R. D., Beloit.
Smith, E. G., Prof., Beloit College, Beloit, Wis.

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

Sciences, Arts, and Letters.

VOL. VI. 1881-83.

PUBLISHED BY AUTHORITY OF LAW.

MADISON, WISCONSIN:
DEMOCRAT PRINTING COMPANY, STATE PRINTERS.
1885.

OFFICERS

OF THE

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS.

Term Expires December 27th, 1884.

PRESIDENT:
R. D. IRVING, E. M., Ph. D.,
U. S. Geologist, Professor of Geology, University of Wisconsin.

VICE-PRESIDENTS:
Department of Sciences—T. C. CHAMBERLIN, A. M., Ph. D.,
U. S. Geologist, Beloit.

Department of Arts—Captain JOHN NADER, C. E.,
Madison.

Department of Letters—WESLEY C. SAWYER, Ph. D.,
Professor State Normal School, Oshkosh.

SECRETARY:
E. A. BIRGE, Ph. D.,
Professor of Zoology, University of Wisconsin.

LIBRARIAN:
A. O. WRIGHT,* A. M.,
Secretary State Board of Charities and Reform.

CURATOR OF MUSEUM:
R. C. HINDLEY,
Professor Racine College, Racine.

TREASURER:
HON. S. D. HASTINGS,
Madison.

* Resigned, 1883.

TWELFTH ANNUAL MEETING.

DECEMBER 27 AND 28, 1881.

PROGRAMME.

TUESDAY, DECEMBER 27.

Business meeting.

WEDNESDAY MORNING, DECEMBER 28, 9 o'clock.

Paper: "Land Communities among the Ancient Germans." — W. F. ALLEN, Professor of Latin and History, University of Wisconsin.

Paper: "The Number, Distribution and Function of the large Ganglion Cells of the Frog's Spinal Cord." —E. A. BIRGE, Professor of Zoology, University of Wisconsin.

Paper: "The Causes of Insanity."— A. O. WRIGHT, Secretary State Board of Charities and Reform.

Paper: "Medieval German Schools." —J. D. BUTLER, LL. D., Madison.

Paper: "The Dispersion of Drift Copper."—R. D. SALISBURY, Beloit.

WEDNESDAY AFTERNOON, 2 o'clock.

Held in Lecture Room of Natural History, No. 36, Science Hall, University of Wisconsin.

Paper: "Recent Observations on Cell-Divison and their Relation to Theoretical Zoology.— E. A. BIRGE,

Paper: (1) American Glacial History in the Light of Recent Investigations. (2) The Harmony of Recent Observations on Moraines, with Croll's Hypothesis of the Origin of the Glacial Epoch." —T. C. CHAMBERLIN, State Geologist, Beloit.

Paper: Proportional Representation in Legislation." — G. SCHUMM, Editor *Radical Review*.

WEDNESDAY EVENING, 7:30 o'clock.

Paper: "My Visit to the Hawaiian Volcano." — PROF. J. D. BUTLER.

Paper: "Human Liberty Empirically Considered." — PRESIDENT JOHN BASCOM, State University.

FREEDOM OF WILL EMPIRICALLY CONSIDERED.

By JOHN BASCOM, D. D. LL. D., President University of Wisconsin.

It is not our present purpose to present again the proofs of liberty in human action. These proofs are so primitive in their charater, approach so nearlythe first principles of reason, that later discussions of them between the defenders of philosophical systems do not often subserve any purpose of conviction.

The object we now have in view is a consideration of liberty as it offers itself in experience, first, in the relation of the mind to the brain; and, second, in the reaction between the powers of the mind and the products of those powers in the world about it. If we were to grant liberty theoretically, should we find its exercise possible under our present experience? This is the question we wish to answer.

It will not be amiss to remind ourselves in starting of the nature of the interests involved in this discussion of liberty. Moral facts are supreme facts in human society. The axiomatic principle on which these rest in the general mind is, Responsibility is commensurate with power. This involves at once choice as the indispensable condition of virtue. We are not considering in morals a balance of tendencies, but a balancing of tendencies—a dealing of the mind with tendencies. No adverse statement at this point has weakened the general convictions on which morality proceeds, or presented itself as more than an ingenious evasion of them. Virtue and liberty rise and fall together: whatever the one loses the other loses also.

The same relation belongs to truth and liberty. Truth is to be inquired into and sought out. It may be attained, and it may be missed. That movement of mind, therefore, which is to be occupied with this work of inquiry, must be flexible and spontaneous; must be at liberty to guide itself by the purely intellectual laws of logic. If thought is in any way subjected to forces beyond itself it can no longer shape itself freely to its own conditions. Conclusions reached under a

physical necessity have nothing to do with truth. They are facts, not truths. The laws of logic are not laws in this sense, the mind must move logically; but in this sense, the mind must move logically if it is to reach the truth. The implication is that the mind may easily move illogically, and miss the truth; that it shapes its own movement to its own object; that it is free, and that truth is the reward of freedom wisely exercised.

The beauty of the world involves a like conjunction of liberty and activity, though less obviously so. Beauty is fitting thought and feelings rendered in a form wholly suitable to them. Its pursuit involves, therefore, an ideal, and a spontaneous movement toward that ideal. Impulsion and force are alien to beauty. Attraction and freedom are of its very nature.

Nor, indeed, does the plain idea of serviceabless — rendered as man always will render it — lack this notion of liberty. The world is made up of forces that may be used, and of powers in man that may use them. It is made up of the fixed and the flexible, and neither term can be lost and the serviceable process remain. State the case strictly under the forms of empirical forces, and not only do virtue, science, art disappear, use also disappears. We use things in this higher sense when we shape them to our purposes. We use air not when we breathe it spontaneously, but when we fill our air-brakes with it. We use water when we convert it into steam in our boilers, rather than when we drink it under an organic impulse. If the world, both in matter and in man, is made up of forces under settled laws of interaction, man no more uses matter than matter uses man. If we include in the natural what is causal and fixed, and in the supernatural what is free and flexible, the natural can never be in any way handled or interpreted or used without the supernatural. Whenever interpretation reaches either comprehension or use it must do so by virtue of the supernatural, and in behalf of the supernatural. To these ideas of knowledge and of service the one is as necessary as the other. The knowing and using agent is not at the same

time and in the same relation a part of the thing known and used.

Human knowledge and human liberty fundamentally planted in this union of the physical and spiritual, as we here conceive them, show empirically two lines of limitation. The first of these appears in connection with the brain, the medium by which the mind receives influences, and the instrument by which it communicates energies. We may pass at once to the extreme conclusion which science is approaching, that the nervous system in man, with its great centre, the cerebrum, is constructed throughout with definite lines of inner and outer movement. Organic connections differ from mechanical ones in admitting a greater variety of offices, and allowing a freer substitution of one organ or one method for another; yet a distinct constructive purpose rules an organism as it rules a mechanism. The definiteness of the nerves and of the exterior termini of nerves in the nervous system carries with it a corresponding definiteness of offices both in them and in the great nerve-centres. Exactness in superficial relations without exactness in interior ones, would be futile, the meaningless juncture of order and disorder. The distribution and precision of the surface indicate like exact inner relations in completion of the one plan. Observation of the effects of obstruction and of disease in the brain, and of artificial irritation of its different localities, serves also to disclose explicitness of office combined with organic flexibility.

There is nothing in this which liberty may not easily accept. This dependence of the mind on the body gives strict conditions to liberty, but does not take away its first terms. The tool is an instrument to the hand; the hand is an instrument to the brain; the tool, the hand, and the brain are conjoint instruments to the mind. The workman cannot go beyond the possibilities of his tools. His circuit of liberty lies within those possibilities. The mind united to the body receives from it what we may call two sets of limitations, or two sets of powers as we choose to regard them: those which pertain, in the senses, to the ingress of knowledge, and those which pertain, in the muscular system, to its egress in ac-

tion. The nervous system is the medium in each case, and the bond between the two.

The only view which at all interferes with liberty at this point is that which regards all action in consciousness as a secondary accompaniment of this interplay of stimuli and activities in an organism, and so determined in its phenomena by it. If the chief nerve-centres, more especially the cerebrum, in man are the seat of a series of interactions which take place between the inward movement and the ontward one, and are governed by them; if the phenomena of consciousness are simply the accompaniments of these complex actions and reactions in the brain, then liberty is lost, not limited, by such conditions.

The adverse reasons are many. (1) A very large share, much the largest share, of nervous interplay goes on both in the lowest and in the highest life without consciousness. Consciousness is certainly no necessary product of merely nervous interaction. (2) Consciousness regarded in this light is from beginning to end a superfluous term. If consciousness is incident to forces seeking directly their own ends, we have no more use for consciousness in living than in dead things; no more need of it in securing the muscular activities that follow thought than in the circulation of the blood, or in uniting the recognition by the eye of the characters on the printed page with the muscles of the throat in articulation. If no state of consciousness is of itself productive of subsequent states of consciousness, but all are alike dependent on underlying cerebral conditions, then each state of consciousness and the entire series of states are, in reference to physical events, supernumerary results. Between these states and these events it is impossible to affirm any correspondence which is of the nature of knowledge. (3) Consciousness has been introduced in development, on the contrary, as a new term in a higher life, incident not simply to organic relations, but one that seems greatly to extend them and put them to new service. (4) There is no known counterpart of any given thought in any given molecular changes of any nerve substance. The first and fundamental step of proof in this direction has not yet been taken.

The whole theory of correspondence has not one explicit fact to sustain it. The senses are definite in their outer conditions and inner impressions; the activities are definite in their inner conditions and outer effects; but our experience does not extend or cannot extend to any pure mental state as the exact counterpart of a physical one embraced between these two lines of ingress and egress. Arguments looking to such a conclusion are all inferences from insufficient grounds.

There are two contrasted views that we may take of the relation of the processes of pure thought to cerebral action. We may regard them as strictly incident to cerebral changes which intervene between sensation and action. This supposition implies an exact and causal connection of each specific cerebral state with a corresponding state in consciousness. The line of efficient forces is thus maintained in the physical world. Or, we may regard pure intellectual activity as a distinct term, under its own laws, which is introduced between sensor impressions and muscular actions, as the musician is an independent agent between the sheet of music that lies on the piano and the instrument itself. On this supposition the mind as mind receives impressions, correlates them in its own fashion, arrests them or passes them on in effects according to its own ends. We may, if we choose, modify this second opinion by still further supposing that there is a distinct molecular state of brain as the necessary accompaniment of each thought, but that it is secured by existing states of mind and not by antecedent sensations. This expansion of the theory, however, seems to be a weak concession to physical ideas, as no such correspondence can be proved, and the cerebral states thus accompanying pure thought would have causal connections neither with antecedent nor subsequent cerebral states, would be a dead term in the material world, and serve no known purpose in the mental one.

This intervention of mind does not imply any chasm in physical sequences, any break of relations between sensations and actions, but simply the power of the mind to penetrate, and in a great variety of ways to modify, these

connections; thus heat alters physical sequences, without interrupting them. The change does not lie in the insertion of alien terms, but in the control of congenital ones.

Several empirical reasons are urged for the strict dependence of thought on cerebral states. In insanity, it is said, the mind is subverted in its action simply by disease of the brain. But this it should be under either view. The mind is dependent for its facts or supposed facts on a nervous organism, and an abnormal state of the organism may wholly alter the data of thought. The quickness, however, and accuracy with which the patient reasons from his premises are often very observable. If the sensor and active physical powers are broken down by disease, the mind on the one side loses data, and on the other side the power of expression. Aphasia, or the inability to utter or to write words, is often offered as a proof of this dependence. This fact, however, seems to look in the opposite direction, as the idea is still grasped by the mind even when it cannot control the organs of utterance.

But the experience which looks most directly to a constant and complete dependence of thought on cerebral conditions is the sense of fatigue and the waste of nerve-tissue which accompany the action of mind. This fact requires careful consideration. Under all theories the brain is the medium of impressions and expressions, and the action of the mind lies between the two. The only question is whether it lies as intervening cerebral links between cerebral states, to which connection thought is incidental; or as a relatively independent spiritual power to which no cerebral state need be set apart. In either case the action of mind involves sensor activity and motor activity, and this, too, in a much higher degree than is usually thought. It is this incipient or complete ministration of sensor and motor action of the brain to the mind that we would regard as a sufficient explanation of the fatigue of mental activity.

Things and words are the counters of mind, and without them it can make only the feeblest advances in reflection. But things involve sensor impressions, and our acts of attention, analysis, and arrangement involve sensor impressions

and motor activities. The sensor and motor terms are as omnipresent in inquiry as are the two poles in an electric current. Still more if possible is this true in the use of words, the most intimate and constant means of thought. When the words of others direct us, they become sensor impressions that call for careful attention. When we ourselves guide our thoughts by words, they are either distinct motor terms or *quasi*-motor terms.

All acquisition commences with language and seeks its constant aid, and as language has a definite cerebral term involved in its use and expression, we find in this fact an occasion for a consumption of nerve-tissue in all mental action. Children, if circumstances admit the habit, prefer to study aloud; that is, to aid the comprehending process by a full use of its counters. If the habit is inconvenient, the pupil will often move his lips without emitting any sound. He still finds the incipient utterance of the accompanying words a help to the mind. Some adults are aided in understanding a book by reading it aloud. All persons observe the much greater clearness of thought which follows the utterance of one's conclusions or the writing of them. Even dreams frequently lead to talking in sleep. All these things show that it requires considerable effort on the part of the student to reduce the language which he employs in thought to its lowest terms in nascent expression.

A little attention to our mental processes will show us that language never disappears in thought, but that our most silent processes still go forward by its aid. This dependence of thought on expression is also well illustrated in the education of mutes. "Though the deaf-and-dumb prove clearly to us that a man may have human thought without being able to speak, they by no means prove that he can think without any means of physical expression. . . . Herein lies the necessity of utterance, the representation of thought. Thought is not even present to the thinker till he has set it forth out of himself. . . . The deaf-and-dumb gesticulate as they think. Laura Bridgman's fingers worked, making the initial movements for letters of the finger-alphabet, not only during her waking

thoughts but even in her dreams. . . Heinicke gives a description of the results of his teaching his pupils to articulate, their delight at being able to communicate their ideas in a new way, and the increased intelligence which appeared in the expression of their faces. . . . The teachers of Laura Bridgman used to restrain her from making inarticulate sounds, but she felt a great desire to make them, and would sometimes shut herself up and 'indulge herself in a surfeit of sounds.' But this vocal faculty of hers was chiefly exercised in giving what may be called name-sounds to persons whom she knew, and which she would make when the persons to whom she had given them came near her, or when she wanted to find them, or even when she was thinking of them. She had made as many as fifty or sixty of these name-sounds." * These cases indicate the aid which the mind immediately receives from any method of expression, and the consequent pleasure it takes in it.

Deaf mutes are accustomed, in acquiring their lessons, to spell out the results on their fingers. The training of imbeciles opens with an effort to give them a better control of their hands, their senses, and their organs of speech. Impotence, vagueness, uncertainty in these directions are the expression of kindred mental qualities. One who does not articulate words well finds difficulty in recalling them.

When a name we have forgotten is rightly articulated we recognize it at once. Language is the full realization to the mind of its own activity. We are also to bear in mind the greater fatigue which attends on thought when it receives full vocal utterance, as in oratory. The accompanying activity of the nerves and organs of articulation with the necessity of continuous and rapid expression often make the fatigue very great. This labor is also much increased if the subject discoursed on is one whose vocabulary we have not fully mastered, or if the discussion is carried on in a language with which we are not perfectly familiar.

On the other hand, an exact but familiar process, as the multiplication of large numbers, is much more trying if we

* "Early History of Mankind," pp. 67–74.

are compelled to carry it on mentally, and are not allowed visible counters. In this case the steps are no more difficult, but the difficulty of retaining them is greatly increased. Mere reverie, in which the transitions are very loose, is restful rather than fatiguing.

It is an ultimate fact in neurology that connections once established in images or in actions, become increasingly easy and spontaneous. The power to utter words by rote, into which complete memory is constantly passing, is plainly the result of nervous and muscular training. Literary matter which has just been learned can be repeated but slowly and hesitatingly. A repetition on successive days greatly increases the facility of movement, and a repetition at distant periods very much strengthens the hold of the mind. We often render aloud lines of poetry, giving full sway to the rhythm, as a means of recalling one or more missing words. The loss of memory by disease and its restoration of health find explanation in these neural connections. More recent occurrences suffer most from this loss of recollection, and the power of memory returns by first regaining more distant events, those whose connections have been fully established in the nervous system. This method of restoration is made plain by the simple fact that memory is supplemented by vital connections in the nervous system of perceptions and of actions. A memory which easily lays hold of an idea, but retains with difficulty the precise words in which it is stated, is doubtless to be explained by diversity in the cerebral conditions of language; as much as is hesitancy in speech as contrasted with volubility. Memory is evidently much modified by the fact that it so often involves the physical condition of expression.

More than one instance of this kind has come to my knowledge. A person, awakened from a deep sleep, has recalled certain thoughts that were present to the mind, and also words that accompanied them. Giving the subject closer atention, he has been surprised to find that the words did not belong to the thoughts, but seemed to have been evoked vaguely by them. The thought-process stirred the faculties of expression without controlling them. In like

manner sounds that enter the ear are distorted in dreams so as to suit the circumstances of the dream, rather than the external fact. Both of these results indicate a momentary separation between the thinking process and the organs of expression and preception which accompany and sustain it.

The hesitancy and difficulty with which the mind sometimes meets in trying to recall a word seems to lie in the feeble hold of the memory on the one side, and the inability of the mind to guide the organs of utterance on the other. The image of the written word and the sound of the word are both partially present, and both fail of perfect form. Thus one may have uttered yesterday a difficult sound, and have lost to-day the power of repeating it.

If we allow an exact correspondence between cerebral condition and pure thought, we confound the distinction between instinct and reason. Instinct is plainly characterized by a direct connection of external stimuli with appropriate actions; the transition being, however, more or less protracted, and united with the ordinary variable experiences of life. Reason, under the view now combated, would be simply an extension of instinct, whereas it manifests itself not only as a new combination of powers, but also as one that is constantly setting instinct aside and reducing it to its lowest terms.

This theory of an exact correspondence between cerebral states and rational activity makes no sufficient and no plausible provision for the growth of rational powers. Cerebral states and cerebral actions are not inexhaustible. If a distinct combination is demanded by each distinct thought, and if memory requires the preservation of these combinations, the capacity of the brain would be steadily exhausted by its development, and we should experience in reason, as we do experience in instinct, limits to mental unfolding. So small a substance as the brain cannot, in its molecular states, be the counterpart of the entire universe in all the actual and possible relations of its parts. There must be some limit to the discursus of reason if each thought appropriates a definite portion of a limited power. The theory is unreasonably complicated, and in that degree

improbable. It would also imply increased difficulty in the acquisition of mental power, when the facts disclose increased ease. Nor is it any relief to this embarrassment to say that the special senses, like the eye, give the mind very complex impressions by an equally complex organic state. The image of a landscape is displaced by each succeeding image. The eye is a specialized organ that has been developed to its present power by stages of growth that date back almost to the beginning of animal life, and yet its maximum power is represented in the reproduction of a single landscape, with very great limitation of distinctness of vision beyond the immediate centre of observation. The method and degree of reproduction in the eye and the ear give no color of plausibility, but the reverse rather, to the supposition that the cerebrum has in its molecular action an exhaustless representative and retentive power both in the regions of imagination and of abstract thought.

Mathematical truth and all exact knowledge lead to the opposite conclusion. Cerebral states as physical effects can never be the precise counterparts of each other in different brains. No truth, therefore, dependent on such states could be absolute and universal. Some kind of color-blindness would sooner or later show itself in all directions.

The deductive reasons already referred to come in to confirm this conclusion of the relative independence of pure thought in an unmistakable way. No physical relation can be the equivalent of logical convictions; and no convictions can be merely physical effects. The two lines of law are not parallel, and cannot be made the counterparts of each other. The conditions of thought are not those of force.

We may then pass all strictly physical experience as indeed giving limits to liberty and sometimes limits crowding very close upon it, but limits that never abolish it as long as thought remains. We turn now to our intellectual experience in its relation to freedom.

Men start with a balance of powers and a bias of disposition which are not easily modified or resisted. This natural disposition is the result of primitive passions and tastes that are stubborn facts by no means to be wiped out by a simple

choice, nor indeed altogether to be rooted out by the most faithful and continuous effort. A portion of these proclivities may be attributed to physical inheritance, and a portion to original endowment. For our present purpose we need not strive to settle the balance between them or even stop to enforce the existence of the second constituent. The position of the individual in reference to liberty is not much altered whether his first make-up comes to him by descent or by gift, or by a combination of the two. The stubbornness of these first tendencies experience clearly records. Those who have the training of children attach great importance to parentage and antecedents. Even in the earliest instruction these forces make themselves felt. The parent and the teacher are constantly aware in the same household of diversities of temperaments and tastes as fundamental considerations in discipline. It is true that much more can be done in shaping these forces early in life than later in life, but they can at no time be overlooked, and will often undo unskilful and even skilful labor in a sudden, resentful way.

It is also to be remembered that the moral inheritance of early surroundings and discipline so adds itself to, and incorporates itself with, primitive endowments as to be practically inseparable from them. By the time a young man begins to come within the range of his own personal freedom a composite stream of strong currents has him in hand. He need not lose time to inquire how he came by his inclinations, whether by native endowment, by physical inheritance, or by direct instruction; to guide and shape these energies, already realized in volume and direction, becomes his sufficient labor. The limitations of liberty are, therefore, very obvious and very great. They are allied to those of a gunner whose position and piece are given him. Said an active boy in answer to the complaints of his sluggish companion, "I do not walk so fast on purpose, I cannot help it." If we look at the limitations of liberty in reference to the immediate actions that are to follow them, we may regard freedom as not having much to do with the ordering

of life. Indeed, hasty reasoners often come to this conclusion.

A restriction closely concurrent with this of primitive disposition is that of habit. We all become increasingly aware of this restraint as we advance. We are not simply hampered by physical habits, but by intellectual ones also. The lines of thought we have taken up we pursue with increasing ease, but we are at the same time more and more reluctant to accept new ones. In youth we were adepts in mathematics or quick in languages; in middle life we discover we have much narrowed these powers by disuse. We have passed the point of indifference in reference to any class of attainments, and find them all positively easy or positively hard.

The convictions we have reached, especially those touching action and character, personal, social and religious, though they themselves may have grown up in the exercise of liberty, are still limitations upon it. Especially is this true if a dogmatic spirit enters into them and we regard our opinions as finalities.

What Lanfrey says of Napoleon is capable of much wider application. He is speaking of wilfulness — which is really the want of well-ordered will — as united with very great intellectual powers. "The studied frenzy of a calculating mind is without remedy, because it does not depend on a sentiment, but on the very form of the intellect itself." This is true of all mental activity in proportion as it becomes deep and narrow. The life flows on in it as a river in a cañon, not merely beyond flexion, but for the most part beyond observation. A dogmatic intellect does not simply open before us one way, it systematically closes up all other ways. Dogmatism is a universal loss of liberty, and most of all in the inner life of the mind.

The remoteness of primary principles from the truths which flow from them leads to the same result. Most of the discussion by which the current of empirical philosophy is resisted in our day goes for little or nothing. It lies far out among marginal truths, and can find no acceptance with minds adversely disposed, and rarely leads to a fundamental

renovation of thought. A boy sits upon the bank of a stream and gives his slight boat an impulse up the current; it soon returns to him, because the water flows in the opposite direction. The tidal movement of many minds is something not often comprehended, difficult to be resisted, and hard to be overcome. While the questions involved are questions of reason, the questions are very many, and the reasons very many, and are arrayed like armies. Single men or single regiments of men, can no longer wage successful war.

Another restraint which overtakes freedom in its unfolding is that which arises from the accumulating force of feelings and of social relations. It is thought that the minds of women are less open to the force of reason than those of men. So far as the assertion is true, it is largely due to the emotional energy which characterizes them. This medium of thought refracts and colors the light on all personal topics, till a presentation is insensibly reached that suits the temper of the inquirer. Light is full of all colors, and will yield them all according to our analyzing prism. Wise men find that in dealing with the foibles of others they must not expect to remove them, but rather to accommodate themselves to them. Friends that undertake thoroughly to correct each other will soon reach aversion. Refractions that belong to the very atmosphere of the mind itself must be patiently borne. It is far easier for those who see these disturbances of vision in others to endure them than for those who suffer under them without recognition to remove them.

Not only are the feelings themselves very persistent forces, all our social relations become objective provocations to them, renewing them constantly and with great energy. As we interpret society to-day we interpret it to-morrow; and it acts on us vigorously to perpetuate ruling impressions. Hence it is not our own emotional atmosphere simply, but the atmosphere of the world we live in, that is unbraiding the light for us, and casting sombre or brilliant colors on the objects about us. To these physical and intellectual restrictions are to be added secondary ones which arise from their interaction. Disease, fatigue, old age, success, failure, predispose the mind to certain judgments which are not eas-

ily cast off. The unsuccessful man becomes untrustworthy in his opinions.

We care not to trace these limitations further, but wish rather to inquire how they leave the problem of liberty. So profoundly are some minds impressed with these subtile and overwhelming influences that human liberty sinks out of all high estimate. Life seems but a painful beating of the waves of the ocean by a swimmer who must ultimately sink. Constraining forces are of the most pervasive and insinuating order; they are often nearest us when we think least of them, and bind us most when we seem to ourselves most free.

Accumulative impressions, like those now brought forward, require corresponding care in the search for compensatory considerations or they quite confound the thoughts. We are too much accustomed to think of liberty as the immediate casting off of restraint, and as efficient, therefore, in the degree in which this is accomplished. This is far from the truth. The value of liberty lies in its power to work under and with invariable and permanent forces. If liberty involved mobility simply, it would lose its possessions as fast as it gained them. The air is mobile, and for that reason its distribution of parts has little interest. We can carve nothing out of it and record nothing on it. Rocks are comparatively immobile, and immediately they become material in many forms of work, while their distribution is an important fact. If results followed on after vagrant wishes, choice would gain apparent power, but would suffer immense loss. The thing done would be as quickly undone, and the clash of choices would be as idle as the collisions of winds. Indeed, there can be but one Aladdin with his magic lamp. He alone must be left to act on things fixed and permanent for all but himself. A pair of them would subvert the world, become spirits with invulnerable bodies who could settle nothing in conflict.

The resistance which surrounding conditions offer to liberty represents the strength and tenacity of the material at the service of the mind, and is a question simply of the right degree. If the resistance is slight, the gains are slight; if

the resistance is great, the labor must be great, but so also may be the results.

Now the individual and the race encounter in the exercise of freedom two lines of resistance: that offered by matter and that offered by the mind itself. The first of these is, in the strictest sense, the coherence and firmness of material. It is the office of mind, availing itself of inorganic and organic laws, to permeate matter and hold it to fixed and extended service. The most complete illustration of this is the human body, penetrated in every part with nerves of sensation and action, and so becoming not itself merely an arena of mind, but a powerful instrument of mind, operating by means of it freely in the physical world. To complete this mastery of mind over matter, to establish it as a settled intellectual dynasty, is what wise men are about in the world. Now material laws are sufficiently pliant to thought to make this labor possible, and sufficiently resistful to make the gains of infinite worth when secured. Men soon learn that mere vaporing accomplishes nothing, but they also learn that skill and patience are surprisingly effective. The stream does not flow like water, but it flows like a glacier. It can hardly be said that the physical material offered the hand of man is so intractable as to waste liberty; it has rather that degree of tractability which stores liberty.

But the second line of resistance is one of equal interest — the restraints which the laws of mind offer to mind. It has been found a universal social law, that if freedom is to grow, wisdom and virtue must grow with it. It is the same truth we are contemplating in the limitations of liberty within the mind itself. The agency slips away from the agent unless the agent masters himself also. While man is held back from the control of the physical world by laws within that world, he is equally held back by laws within himself, and the two sets of laws must be handled together and mastered together; otherwise the movement will soon find arrest. When the mind stagnates within itself its external force is lost also.

What do the limitations of freedom which we have found arising within the mind itself signify but this, that the grow-

ing points of intelligence and virtue must be carefully maintained? If these are lost, freedom is lost. The mind settles down under fixed opinions, becomes subject to an unbroken sequence of feelings, and accepts the social sentiments that prevail about it.

The one condition of freedom is to maintain unimpaired intellectual activity in all directions of action. This alters the horizon, varies the grounds of effort, breaks up and subordinates habit, and holds in arrest the aggression of other minds. The mind that ceases on any topic — for instance, on that of religion — from fresh intellectual activity has turned down the light by which it should be guided, and it is only fortunate, therefore, that it begins to fall into a calculable routine of action, that it does not go plunging on with nothing to direct it. When the buds of a tree cease to shoot the leaves may come and go for awhile with the seasons, but the constructive life is arrested. The limitations of liberty do not show the power of man to be nothing, but only that there are moments, places, and ways of its skilful application.

We are not to conceive liberty in men as a gigantic power, easily executing its purposes and holding fast results with a firm grasp. We all start under conditions alien to ourselves, organic influences, educational influences, social influences. Here is a young man brought up on a farm to hard labor, close economy, and a limited intellectual horizon. External circumstances and parental precept and example have concurred in deepening the ruts in which he is slowly moving onward. None the less it is possible that some new activity shall come to his thoughts, that he shall of a sudden say to his astonished father, on the occasion of some new exaction, "I do not think so." From that moment he may begin to break the cords that have bound him, and, in the progress of years, get to himself new incentives with a new outlook. Motives have force, not in themselves, but in relation to the mind to which they appeal. Change the mind and you change the motive. When a man thinks to some some new purpose the chains of custom drop off him. Every man, in his experience, is liable to share the astonishment

of the father, when his son says to him for the first time, "I think differently." As a man thinketh so is he. Here is a pivot of revolution which no external facts can control, but upon which they in turn are dependent. If we introduce liberty in human action at this centre of thought, and leave it to extend itself by a steady modification of internal conditions, and to maintain itself by fresh acquisitions, freedom is reconcilable both with the theory of life and the facts of life, and is seen to be the one significant factor in them both.

If there is a slow accumulation of circumstances about one which hedge the way, the fact is due to the passivity of the mind in the ripening of events. If the mind is active and watchful, this infinite division of particulars, this slow gathering of difficulties are in favor of liberty. By foresight and effort the mind increases its powers of resistance and guidance. The problem of life is indefatigable will at war with unwearied forces, but forces can be divided against themselves, and enlisted on the side of will.

While spontaneity exercised in thought — and in this way productive of light — is the condition of continuous freedom, the condition of the condition is virtue, feelings that turn on and subordinate themselves to the truth. If the intellectual movement is not honest in its incipiency it shortly fails of thoroughness. It is not light alone that is the efficient constructive force in the green tissue of leaves; it is light and heat. It is not truth alone that maintains the vitality of growing points in the mind, but truth and feeling. Feelings that are alien to the facts soon alter our conception of the facts, and so the facts shake us off and escape us. We are not masters, because we have lost the true word of command.

Personal liberty is like liberty in the state. Its safe possession is one of profound obedience to deeply implanted principles. It is not, therefore, the less liberty or of less worth. On the one side the very condition of strength is a struggle with domineering tendencies, and on the other their steadfast government under new conditions. Liberty is a movement from law to law, each succeeding law being higher, broader, more inclusive, and more fortunate.

The value of liberty is that it enables the mind freely to conform to law. The liberty that does not pass instantly into law is like the seed that is not sown in the soil. It abides alone. Liberty that confines itself to its narrow field, that is content to knit skilfully together the past and the future at the one plastic point, the present, is not weak, it is well-nigh omnipotent. It only requires long times and large spaces in which to unroll its power; it merely calls for material of every order and the union of every law by which to record its work. There is no reason in any limitation of liberty why, under the laws of inheritance, man should not in time walk the earth with the bounding life of an archangel, govern it with the strength of an archangel, and take home its thoughts and feelings to the pure and serene experience of an archangel.

The one law of this progress is continuous intelligence and virtue.

THE INCREASE OF INSANITY.

By A. O. WRIGHT, Secretary of the State Board of Charities and Reform.

The United States census of 1860 showed in the state of Wisconsin 283 insane persons. The census of 1880 will show probably about 2,000. This is not an isolated fact. An increase of insanity is shown by these two enumerations in the twenty years from 1860 to 1880 in every state of our Union, and in some of them as great an increace as in Wisconsin. Is the increase a real increase, and what are the causes of it?

I. This is not all a real increase. The census of 1880 was taken much more accurately than ever before, and this increased accuracy shows itself especially in the enumeration of the defective classes. The United States deputy marshals were sometimes careless in counting the numbers of population, and much more careless in gathering such special statistics as those of the defective classes. Their sins were

generally of omission rather than commission, and therefore the more accurate methods of the last census caused an apparent increase in the number of the insane, as of all the defective classes. Thus this census will show in Massachusetts one insane person to every 338 of the population instead of one to 350 as before supposed.

II. An apparent increase of insanity is caused by the wider definitions of insanity given nowadays by physicians in charge of insane hospitals. A wide range of diseases of the brain and of mental and moral perversions is now called insanity, which formerly would have been called nervousness, or eccentricity, or wickedness, as the case might be. Consistently with this theory an expert witness lately testified in the Guiteau trial that one in five persons on the average are insane. The effect of these teachings has been to cause many persons now to be considered insane who formerly would not have been so considered. The disease or the mental or moral perversion would have been there, but it would not have been called insanity. The increase of insanity from this cause is like the astonishing increase of some cities, made on paper by taking in outlying suburbs.

III. A very large apparent increase of insanity has been made by the better care now taken of the insane than formerly. The barbarous treatment of the insane which lasted as the rule in Wisconsin down to about 1860, when the State Hospital was fairly opened, and after that in most jails and poorhouses until after the State Board of Charities and Reform began their work of improvement of those institutions in 1870, and which is still found in a few places in this state to-day, tended to greatly shorten the lives of the insane. Living in filth and squalor, chilled by frost and scorched with heat, given too little food and drink, shut in dark, damp dungeons away from the healing beams of the sun, they died rapidly. Now, under humane treatment, with proper food, warmth, exercise and fresh air, the chronic insane live at least as long as the average of mankind. There is little in the mental disease itself to destroy life, and people cared for according to the laws of health in hospitals and county asylums are less liable to disease and death than

those who are free to neglect their health outside of insane asylums. Now this process of preserving the lives of the insane has been going on in this state for the last twenty years with the inevitable result of increasing the number of the insane. For while as many have been becoming insane as ever, fewer have been dying off, and thus the number insane alive at any given time is growing greater.

IV. Another cause of the increase of insanity is the increase of population. Wisconsin has increased from 775,000 in 1860 to 1,315,000 in 1880. While the population has nearly doubled it is not wonderful that the number of insane should increase also.

V. An important cause of the increase of insanity in this state is that Wisconsin is passing from a new state to an old settled state. The first generation of pioneers who settled the southern part of the state are passing away. When they came here, they were usually people of vigorous health and in the prime of life. Like most settlers of a new country they left their defective classes behind them. There were few insane among the immigrants who came first or among those who have followed them since from the eastern states or from foreign lands. The cases of insanity we have had have mostly been produced upon our own soil. Now, bearing in mind the great part that heredity has in producing insanity, it is plain that a body of immigrants selected for healthfulness of body and mind, as nearly all immigrants are, will have less insanity for several generations than the people of an old settled country. The ratio of insanity to the population will show this. The census of 1860 shows insanity in the ratio of one insane person to every 2,740 of the population. A census which I have recently taken of the insane under public care which is at least as imperfect as that was, because it gives only those under public care, and not those cared for at home, gives a ratio of one insane person to every 743 of the population. This shows a sufficiently rapid increase in the ratio of insanity. But the same census when shown by counties as in the subjoined table, and illustrated by the map which I have prepared, shows very clearly that the in-

crease in the ratio of insanity has been in the older settled counties. Thus the same law is at work within the state as between the counties which is at work upon the state at large.

When the results of the United States census of 1880 in regard to the insane are published, there will probably be about 2,000 insane shown to be in the state or one to every 656 of the population.

Of the five causes for the apparent or real increase of insanity, we may suppose that hereafter we shall have as accurate returns of insanity as the nature of the subject admits of. While it is questionable whether certain persons are insane or not, no one can count the insane with entire accuracy; but they will be hereafter counted as accurately as possible. The second cause in the wider definitions of insanity has gone about as far as it is likely to go in increasing the number of the insane. If anything, there is likely to be a reaction as the result of Guiteau's trial, and of other causes, to narrow somewhat the definition of insanity and thus slightly reduce the number of those called insane. The increase of insanity caused by the more humane treatment and therefore longer lives, is, we may trust, a permanent increase. Rather than resort to the old, barbarous methods, it would be far better to give these poor creatures the euthanasia afforded by an overdose of laudanum. If they are to be killed off, let it at least be done without unnecessary cruelty. But though the increase in the number of insane from this cause is doubtless a permanent one, it will not be as rapid in the future as in the past.

When the expectation of life among the insane has once been permanently lengthened by more humane modes of treating them, they will not continue to accumulate forever, but will die off as before, only at a greater age. We have not yet reached the end of this change for the better in the treatment of the insane. But when we have done so, then this source of increase will soon cease. The increase of population in our state will doubtless go on, but at a slower rate, and with it necessarily that increase in the total number of insane which goes with it. The increase of insanity, which

arises from our state becoming an old settled state, will of course keep on until we attain our fair average.

What that average is becomes then an interesting question. In Massachusetts, as I learn from Mr. F. B. Sanborn, who has charge of that subject there, the rate of insane to the population is about one to 338. In Scotland it is about one to 290. If we assume that we shall reach the ratio of one to 500 under public care in twenty years more, and shall have a population then of 1,600,000, both low estimates, we must expect in 1900 to provide for at least 3,200 insane persons.

If supported in state institutions at anywhere near the rates these institutions now cost, the charge to the public will be at least $640,000 annually, besides $3,000,000 for buildings, a burden which the state will find it difficult to bear. This whole question is one which is now pressing on us for solution and which deserves the attention of every philanthropist and every statesman.

TABLE SHOWING INSANITY IN WISCONSIN BY COUNTIES, 1884.

Counties.	Total insane under public care.	Ratio to population: one to each.	Counties.	Total insane under public care.	Ratio to population: one to each.
Adams	8	825	Marathon	8	2,140
Ashland	0	.....	Marinette	5	1,786
Barron	4	1,756	Marquette	9	990
Bayfield	1	564	Milwaukee	240	572
Brown	44	775	Monroe	21	1,029
Buffalo	5	3,106	Oconto	18	547
Burnett	3	1,047	Outagamie	42	684
Calumet	17	978	Ozaukeee	19	814
Chippewa	11	1,408	Pepin	7	889
Clark	14	765	Pierce	21	845
Columbia	40	700	Polk	9	1,112
Crawford	11	1,422	Portage	14	1,266
Dane	89	598	Price	0	.....
Dodge	67	685	Racine	37	836
Door	11	1,059	Richland	11	1,652
Douglass	1	655	Rock	53	733
Dunn	20	841	St. Croix	13	1,458
Eau Claire	26	769	Sauk	25	1,149
Fond du Lac	78	660	Shawano	9	1,152
Grant	59	641	Sheboygan	54	633
Green	37	587	Taylor	1	2,311
Green Lake	12	1,207	Trempealeau	15	1,148
Iowa	41	576	Vernon	23	1,010
Jackson	13	1,020	Walworth	50	525
Jefferson	58	554	Washington	37	634
Juneau	16	974	Waukesha	46	629
Kenosha	21	644	Waupaca	29	723
Kewaunee	12	1,316	Waushara	9	1,410
La Crosse	37	732	Winnebago	54	751
La Fayette	25	851	Wood	10	898
Langlade	0	.....	State at large	47	.....
Lincoln	1	2,011			
Manitowoc	62	605	Total	1,773	743

THE INCREASE OF INSANITY.

SECOND PAPER. 1882.

By A. O. WRIGHT, Secretary State Board of Charities and Reform.

Last year I presented to the Academy a paper upon the increase of insanity in this state, in which I gave a census of the insane under public care, by counties, the first ever made in the state, showing that we had then 1,773 insane persons under public care or one to every 742 persons in the state, and predicted that we should probably reach the number of 3,200 insane in the state by the close of this century.

I have completed another census of the insane under public care, and am able to give statistics for this year. There were on September 30, 1882, under public care in this state, 1,913 insane persons. This is an increase of 140 over last year. If the same increase occurs for the next eighteen years, or until 1900, we shall have about 5,000 insane persons at that time under public care.

On the supposition that we shall have about 1,600,000 population at the close of the century, that would be one insane person to every 320 of the population, or not far from the proportion of Massachusetts.

But it is not likely that the increase during the whole period will be so rapid, or the number of insane at the end of the century so great as these figures seem to show. In all probability insanity will continue to increase until eventually we reach the ratio of Massachusetts or even of Scotland, one to 290. But this increase will be by a continually retarded ratio. As the number of the insane increases, the rate of increase will grow less, until some fixed ratio is reached, from which the variations will be slight and temporary, as long as the conditions of society remain the same.

The increase, or in some cases, decrease, of insane by counties, is shown by the following table:

The counties which have had the largest increase are:

Milwaukee	27	Chippewa	7
Winnebago	14	Columbia	7
Green	11	Trempealeau	7
Brown	9	Buffalo	6
Sheboygan	9	Calumet	6
St. Croix	8	Iowa	6
Waukesha	8		

The counties which have had a decrease of insane under public care, are:

La Crosse	6	Washington	3
Manitowoc	5	Pierce	2
Racine	4	Eau Claire	2
Clark	3	Green Lake	2
Dane	3	Pepin	2
Dodge	3	Kenosha	1
Door	3	Wood	1
Fond du Lac	3		

The decrease in the insane under public care may come from three different sources: The insane may recover, or at least improve so much as to be discharged from public care; they may die; or they may be returned as chronic insane from the state institutions to the counties, and in consequence of the counties having no adequate provision for them they may be left under private care by their relatives. Decrease, of course, occurred from all these causes, and in the counties just named the decrease from these causes was greater than the increase from new cases of insanity, or from old cases placed under public care. From the fact that none of the counties have had during the past year adequate accommodations for the chronic insane, though some of them are preparing such accommodations, I think it is fair to conclude that in most of the counties this decrease is not a real decrease of the insane, by death or recovery, but only an apparent decrease, caused by sending chronic insane back from state institutions to the care of their relatives.

If this is the case, we shall see another year a considerable increase in the number of insane under public care, owing to the increased accommodations which will be provided in the new county asylums.

I am unable to find any law governing the distribution of insanity in this state, except the one I gave last year, that

the older settled portions of the state have a greater population of insanity than the newer portions. I cannot find that the proportion of native or foreign-born persons seems to affect the proportion of insanity, or that any other of the causes so frequently alleged to be the chief factor in producing insanity, has any considerable influence upon the geographical distribution of insanity in the state.

NOTE: The delay in the publication of the proceedings gives me opportunity to give the numbers of the insane under public care on September 30, 1883. The three years show as follows:

Number of insane under public care in 1881	1,773
Number of insane under public care in 1882	1,913
Number of insane under public care in 1883	2,075
Net increase from 1881 to 1882	140
Net increase from 1882 to 1883	162

As was predicted above, the increased accommodations for the insane provided by the new county asylums, opened in the year 1883, have caused an apparent increase of insanity in addition to the real increase. The real increase, however, has been large.

THE PRIMITIVE DEMOCRACY OF THE GERMANS.*

By W. F. ALLEN, Professor of Latin and History, University of Wisconsin.

The political institutions of the ancient Germans, as described by Tacitus, are of an essentially democratic character. Some of their nations have kings, but royalty is not a necessary part of their constitution, for many nations have no king, and where there is one, he is not invested with any very positive or absolute powers.† Nobles are frequently mentioned, but special privileges or powers are never ascribed to the nobility, and, so far as appears from the in-

*This paper is composed of two papers: one, upon the village community system, read at the meeting of the Academy in 1881: the other at the meeting in 1883. Being properly supplementary to one another, they have been united, and the discussion of both papers brought down to the date of publication.

† *Nec regibus libera aut infinita potestas* Tac. Germ. 7.

formation in our possession, it was a social rather than a political aristocracy. There are serfs, but we are absolutely without information as to their origin or their relative numbers—whether they are Germans, who have sunk from a condition of freedom, or the remnants of a conquered race; whether they are few or many. We cannot, of course, expect to find organized government of the modern type, or any precise definition of powers; but so far as we are warranted in any positive conclusion upon the subject, we may say that the sovereign power was in the hands of the whole people, acting collectively, meeting in a general assembly at stated intervals. (Tac. Germ. 11–12.) The people, in their family organizations, also compose the army;* from a comparison of Tacitus with Cæsar,† an earlier writer, we have a right to infer that these same family organizations live in common occupation of independent districts of land. There are magistrates, holding their office it would seem for life, elected by the people in their national assembly, and acting as a board of administration in the intervals between the meetings of assembly,‡ but also having each his own district where he presides over the adminstration of justice. ‖ From other authorities we know that in this district administration of justice the magistrates only preside; the verdict is rendered by the people of the district in an assembly of the district.

This is a thoroughly republican constitution of society, and this sketch, which rests in every detail upon positive statements of Tacitus, supplemented in only two instances by evidence from other but equally unimpeachable authority, justifies us in the statement that the political institutions of

---

* *Non casus nec fortuita conglobatio turmam aut cuneum facit, sed familiae et propinquitates.* (Tac. Germ. 7.)

† *Magistratus ac principes in annos singulos gentibus cognationibusque hominum quantum et quo loco visum est agri attribuunt.* B. G. vi. 22.

‡ *De minoribus rebus principes consultant, de majoribus omnes.* Tac. Germ. 11.

‖ *Principes qui jura per pagos vicosque reddunt.* id. 12.—*Principes regionum atque pagorum inter suos jus dicunt controversiasque minuunt.* Cæs. B. G. vi. 23.

the primitive Germans were essentially democratic. This is also the conclusion at which we should arrive by the analogy of other primitive peoples, especially those of the Indo-European family. Most of them established a kingly office. most of them had slaves, or serfs, or imperfectly qualified citizens to whom they stood in the relation of a ruling aristocracy; but as a rule all authority is regarded as emanating from the body of the citizens.

There was, however, an institution of the Germans, not inconsistent in its original character with the democratic theory of their institutions, which, nevertheless, must have interfered materially with the democratic working of these institutions, and which in the end effected a complete revolution in them of a strongly aristocratic character. This was the so-called *comitatus*, the body of personal followers. It appears to have been of relatively recent origin, for as Cæsar describes it,* it was quite imperfectly developed, consisting simply in the custom of voluntary leaders in times of war, around whom gathered a group of voluntary followers, the relation apparently continuing only for the period of the war. In the time of Tacitus, one hundred and fifty years later, it has been converted from a *custom* into an *institution;* the relation is a permanent one. The followers live at the expense of their chief in peace as well as war.† There are grades in dignity among them, and the several chiefs emulously rival one another in the number and prowess of their followers.‡

Both Cæsar and Tacitus use the word *princeps*, "chief," to designate the leader of the *comitatus*, and this is the same word which is used by both writers to designate also the permanent magistrates who have been already described. The question has naturally arisen, and has been debated with

---

* *Ubi quis ex principibus in concilio dixit se ducem fore, qui sequi velint profiteantur, consurgunt ii, etc.* Cæs. B. G. vi. 23.

† *Epulae et quamquam incompti largi tamen apparatus pro stipendiis cedunt.* Tac. Germ. 14.

‡ *Gradus quin etiam et ipse comitatus habet judicio ejus quem sectantur: magnaque et comitum aemulatio, quibus primus apud principem suum locus, et principum cui plurimi et acerrimi comites.* Id. 13.

considerable warmth, whether the right of entertaining a *comitatus* was confined to the magistrates or chiefs of the state. Some have held that any person who chose might gather about him a body of followers; others, on the other hand, have taken *principes* in this relation to mean "nobles," and have regarded the right as a privilege of nobility. I have already said that neither Cæsar nor Tacitus ascribes any political privileges to the nobility, which appears, therefore, to have been a purely social distinction; and this statement is correct, if we take only the terms *nobiles* or *proceres* to mean "nobles," they being the words regularly used in this sense. The word *principes*, on the other hand, does not properly mean "nobles," but "chiefs" — individuals invested with certain governmental powers. It is purely begging the question to assume that, in relation to the *comitatus* it is used in a different sense from its usual one. But the connection in which the word is used is conclusive upon this point. Both the writers in question speak of the *principes* as magistrates before speaking of them as leaders of the *comitatus;* and in Tacitus the passages follow close upon one another with no interruption. He passes directly from the election and the judicial functions of the *principes* to the description of the *comitatus;* the conclusion is irresistible that the *principes* who maintain the *comitatus* are the same as those who administer the government of the state and preside over the judicial assemblies of the districts.

It will be readily seen that an institution like this, which, as Tacitus says, had a direct interest in war,* must have had a powerful influence in converting a peaceful community of peasants into the turbulent and quarrelsome nation of warriors who invaded and overthrew the Roman empire. But our immediate connection is with the constitutional change which it effected. We see a body of elected magistrates (to use a modern term) holding their office for life, and therefore, virtually irresponsible, administering the government in the intervals between the assemblies, having the administration of justice wholly under their direction and

---

* *Magnum comitatum non nisi vi belloque tueare.* Germ. 14.

gathering about them a body of armed retainers, whom they support in peace as well as in war, but whose interests are wholly in war. The elected magistrates are to all intents and purposes converted into barons, holding their fellow-countrymen in control by armed force. Moreover, although there is no indication and no likelihood that nobility of birth was a necessary qualification for the office of *princeps*, it was natural that an office of so much power would be filled almost exclusively from the wealthy and distinguished members of the nobility. The *principes* were not nobles as a class, or by any necessity; but as individuals they must in almost every instance have been of noble birth.

We are able, in the light of this condition of things, to interpret the single passage which has appeared to identify the *principes* with the nobles: Tacitus Annals, i. 55, where it is said that Segestes, the friend of the Romans, urged the Roman general Varus, in view of the impending revolt of his countrymen, to put in custody both himself, his rival Arminius, and the rest of the nobles — the common people would venture upon no movement when they had lost their chiefs.*

The *principes* and the *proceres*, in their origin wholly different — the one elected magistrates, the other a social aristocracy — became identified with each other; the office of *princeps* would tend to become hereditary, and the social aristocracy was gradually converted into a political aristocracy.

The primitive and fundamental democracy of the Germans was, therefore, in the time of Tacitus, confronted by a wealthy and powerful official aristocracy, the forerunner of the feudal nobility. By the side of the national army, the organic divisions of which were formed by groups of kindred, there appeared the bands of military followers, fighting under the leadership of their personal chief, who at the same time, in his official capacity, must have commanded also the national host. By the side of the primitive communities of free tribesmen, also composed of family groups, there appeared the baronial residences of the chiefs,

---

* *Ut se et Arminium et ceteros proceres vinciret: nihil ausuram plebem principibus amotis.*

like feudal castles among the villages of peasants. Both of these systems, the democratic and the aristocratic, are clearly described in the Germania of Tacitus, the work in which he treats of their institutions from an antiquarian point of view. In his historical works, where the Germans are introduced, we see clearly the aristocracy as the preponderating force. The same appears also in native pictures of Germanic life, like the poem of Beowulf and the Icelandic sagas.

In two books published within the past year by Mr. Frederic Seebohm,* an eminent English writer, and Mr. D. W. Ross,† of Cambridge, Mass., these baronial — or, as Mr. Seebohm prefers to call them, manorial — features of the primitive Germanic constitution are sketched with great learning and cogency. Other writers have emphasized the aristocratic features of this constitution, but to Mr. Seebohm, approaching the subject from an economic rather than a historical point of view, belongs the credit of having first pointed out that the German institutions were working themselves out upon "manorial lines." But, just as the generally accepted democratic theory undervalues the aristocratic elements of German society, so Mr. Seebohm appears to undervalue its democratic elements. To him the German institutions appear to have been fundamentally aristocratic, while the sketch given above represents the aristocratic features as a relatively late outgrowth.

The argument of Mr. Seebohm and Mr. Ross, is founded principally upon a passage in the Germania of Tacitus (Chap. 16), which we will now proceed to consider. It is as follows: "They dwell separate and scattered, as a fountain, a plain, or a grove catches their fancy. They build their villages, not like ours, with houses touching one another, but each house has a space about it."‡ Here are two modes of habitation described — that of villages, and that of iso-

* English Village Communities. London. Longmans & Co.

† Early History of Land-holding Among the Germans. Boston. Soule & Bugbee.

‡ *Colunt discreti ac diversi, ut fons, ut campus, ut nemus placuit. Vicos locant non in nostrum morem connexis et cohaerentibus aedificiis: suam quisque domum spatio circumdat.*

lated homesteads. The passage, like most passages in ancient works, has been variously interpreted; the interpretation of Mr. Seebohm and Mr. Ross is, that the method first described is that followed by the free tribesmen, and that the villages are of their serfs. This very ingenious theory leaves the democratic features of the German institutions wholly out of account. It represents the free tribesmen as petty barons, each with his village of serfs, and of necessity assumes the free tribesmen to have been a relatively small number of nobles ruling over a large conquered or subject population. It explains half the facts in the case, but leaves the other half unaccounted for, — and this not only in the antiquarian statements of the Germania, but also in the incidental mention in the historians, poets and writers of sagas. For while, as has been already remarked, the aristocratic character appears very strongly in these works, it is no less apparent that the free tribesmen are a numerous, homogeneous body, inferior in wealth and influence, but equally qualified members of the state.

Again, the language of Tacitus does not warrant any so broad contrast between the dwellers in the isolated homesteads, and those in the villages. Mr. Seebohm remarks, (p. 339), that "It is obvious that the Germans who chose to live scattered about the country sides, as spring, plain or grove attracted them, were not the villagers who had spaces round their houses." This we may admit; but when he adds: "We are left to conclude that the first class were the chiefs and the free tribesmen, . . . while the latter, the villagers, must chiefly have been their servile dependents," the inference is not so clear. It would seem that if Tacitus had meant to distinguish not individuals but classes, and especially if he had meant that the one class were chiefs and the other their servile dependents, he would have said so in plain terms. The two kinds of residence are so coupled together, that the only natural inference is that they were alike the residences of the free Germans of whom he is speaking. They are his subject throughout the early part of his work: it is not until he is nearly through with speaking of them,

in the 25th chapter — eight chapters later than the passage under discussion — that he mentions the serfs.

We must conclude, therefore, that the free tribesmen lived in villages as well as in isolated homesteads; and this conclusion is supported by the incidental mention of villages in other relations: for example, in the first book of the Annals, chapter 56, in an invasion of the German territory by Germanicus, Tacitus says that the Germans scattered into the woods, leaving their districts and villages, *amissis pagis vicisque.* If then, some of the free Germans inhabited villages, while others inhabited isolated homesteads; if, further, some of the free Germans fought in companies by family groups, while others followed personal chieftains; and if these personal chieftains were at the same time really noblemen and public officers, it seems probable that it was these chieftains who lived in isolated homesteads, surrounded by their free retainers and their serfs — just as is assumed by Mr. Seebohm and Mr. Ross — while the common freemen, a class ignored by their theory, lived in other villages.

Assuming, then, that the common freemen of the Germans lived in villages, the question arises, what kind of villages were they, and what was the nature of their occupation? In other words, are we warranted in assuming the existence of free village communities among the Germans of Cæsar and Tacitus, as is done by many modern writers. The evidence as to this point is very scanty, being confined to a few isolated statements of these writers, but it is, I think, sufficient to warrant a positive conclusion, partly affirmative, partly negative.

We must begin by defining our terms. The village community is a group of persons occupying a tract of land, which they own and cultivate in common. For the purpose of this common cultivation they must have their residences near together, in a village, from which the arable lands, the meadows, pasture and wood land will be equally accessible to all. The view of the German writers, Von Maurer, Thudichum and others, who have worked up the theory of village communities, is that some communities, *Markgenossenschaften* had such villages, and others not. It is only

those that had them that formed *Dorfgenossenschaften* or village communities proper; and they hold that this was the prevalent form of the occupation of land in the countries occupied by Germanic nations in the early middle ages. The land being owned in common, all members of the community were, originally at least, equal partners; a democratic structure of society is therefore necessarily taken for granted by the theory.

As time went on, individual property in land came into existence. The lands were divided up — the lots occupied by individual marksmen became their property; first the house-lot, then the strip of arable land, became the subject of individual ownership, and when this had taken place, the entire aggregate belonging to one member of the community — house-lot. share of arable land, and right to the pasture, forest, etc. — was called in English, *hide*. Every member, therefore, of the primitive democracy, had an equal property at the outset. The irregularities in wealth and station were the outgrowth of the natural workings of competitive relations in the more advanced state of society.

The question of village communities is essentially a question of the occupation of land, and its theory stands in the closest connection with the history of the origin of the feudal tenure of land. It necessarily involves, moreover, the discussion of another subject, which may be treated independently in other historical epochs, but which in the early history of institutions is inextricably connected with that of land — the structure of society. The reason of this is that, whereas in modern society the state, or political organization, starts with a given territory, and embraces all occupants of that territory; in ancient society it was exactly the reverse. The tribe or nation was the starting point, a given body of persons; and the state — if we may use this expression for this period — comprised whatever territory was occupied by these persons. We see survivals of this primitive condition of things in the tribal organization of our North American Indians. Although occupants of part of the territory comprised within the limits of the United States, they are, nevertheless, not recognized as belonging to that nation, for the reason that they

keep up their tribal organization, with a *quasi* authority over the lands assigned to them by the national government.

The structure of society forms, therefore, the first subject of inquiry in the history of early institutions. And here we notice a still more fundamental contrast with modern society. Modern society, at least here in the United States, has no structure at all beyond the loose institution of the *family;* apart from these petty communities our society is composed simply of individuals with no organic connection with one another, except such as grows out of political relations or private association. But all early societies are highly organized and closely coherent. The man does not exist except as a member of an organization. Any person who stands outside of the organization is in the strictest sense of the term an outlaw. The structure of society must, therefore, be sought first, and the land system will necessarily be an outgrowth of that.

I will first examine the earliest writer, Cæsar, by himself, then see how far the statements of Tacitus agree with those of Cæsar, and what system of society and land tenure may be assumed for both periods.

It has become a common place of political history that early society was founded upon the Family; or, if we go back to the rudest beginnings, where the Family as an institution did not exist, upon Kinship. That this was the case among the ancient Germans, and that the occupation of the land was based upon the family, is testified to in the most positive manner by Cæsar (B. G. vi. 22), where he says that the lands are assigned by the magistrates to the several clans and kindreds of men (*gentibus cognationibusque hominum*). This assignment, he adds, is made for a year at a time (*in annos singulos*), and that it is made at a public gathering, appears to follow from the words *qui una coierunt*, "who have assembled together," where the relative must refer to *hominum*, "men." Among the reasons mentioned for this custom of annual division is the significant one that thus they are able to maintain an equality of possessions (*cum suas quisque opes cum potentissimis aequari videat*, "each one of the community seeing his own possessions

equal to those of the most powerful"). This fact is further emphasized by the statement that no one has land of his own (*neque quisquam agri modum certum aut fines habet proprios*); and he adds that this annual shifting is imperative and under the direction of the government (*anno post alio transire cogunt*). These last statements are found also in the description of the Suevi (iv. 1): *privati ac separati agri apud eos nihil est, neque longius anno remanere uno in loco incolendi causa licet.* "There is among them no private and individual land, nor are they allowed to remain longer than a year in one place for the purpose of habitation."

In these few clear and positive statements Cæsar gives us the materials for determining precisely the stage of social progress reached by the Germans of his time. They were still in the patriarchal stage, in which kinship rather than territory formed the basis of their organization; but they had passed beyond the stage of nomadic life. The individual had no permanent home, neither had the family, but the nation had. More than this, it would appear that there were already certain fixed and determinate territorial divisions of the territory of the nation, for the assignments of land are made with absolute authority by the magistrates, who assign lands and compel the annual changes; and these magistrates, as we learn from Chap. 23, have authority over territorial districts (*principes regionum atque pagorum*). From this we may infer that the shiftings of occupation were made rigidly under the direction of the magistrates, and within the limits of definite territorial districts. Thus Horace (Od. iii. 24, 12) says of the Getæ, a Germanic people:

Immetata quibus jugera liberas
Fruges et Cererem ferunt,
Nec cultura placet longior annua,
Defunctumque laboribus
Æquali recreat sorte vicarius.

Here are clearly indicated the shifting annual occupation, and the lack of any permanent boundaries to the cultivated fields—no ownership, but temporary occupation and use; perhaps also the alternation of agriculture and service in the field, described by Cæsar, B. G., iv. 1. *Singula millia*

armatorum bellandi causa ex finibus educunt. Reliqui qui domi manserunt se atque illos alunt. Hi rursus in vicem anno post in armis sunt, illi domi remanent.

Passing now to the account given by Tacitus, who lived about one hundred and fifty years later, we find that his description partly confirms and partly supplements that of Cæsar: that it nowhere contradicts it, but in some points shows the changes which might reasonably be expected to take place in the course of a century and a half, among a semi-barbarous, but vigorous and intelligent people, in direct contact and constant intercourse with a highly civilized nation.

As to the structure of society, Tacitus testifies, just as Cæsar does, to the persistence of the family principle: only he mentions it in connection with the military organization, instead of the occupation of land (Germ. ch. 7.); *non casus nec fortuita conglobatio turmam aut cuneum facit, sed familiae et propinquitates.* "Their divisions of cavalry and infantry are not made up by chance or accidental assembling, but by families and neighborhoods"— the same patriarchal groups no doubt, which are described by Cæsar's *gentibus cognationibusque.* The two statements naturally form the complement to each other; if patriarchal groups lived together as Cæsar says, they naturally formed military divisions together, as Tacitus says.

Tacitus does not tell us that the patriarchal groups lived together, but it may be inferred that this was the case, from the fact that they fought side by side. When he takes up the subject of the occupation of land (Chap. 26), he merely speaks of the land being occupied by communities, *ab universis.* The passage is so important and so difficult to interpret, that I will cite it at length: *Agri pro numero cultorum ab universis in vices occupantur, quos mox inter se secundum dignationem partiuntur; facilitatem partiundi camporum spatia praestant. Arva per annos mutant, et superest ager.* "It is their practice to have their lands taken into possession by communities, turn by turn, in amounts proportioned to the numbers of their members, and afterwards to share these out among the members ac-

cording to rank; the wide extent of the tracts occupied makes this division easy. They change the fields in cultivation every year, and there is land left over."

Here we have, just as in Cæsar's description, a periodical shifting of occupation, and this is the only feature of the two descriptions which we identify positively. For the reasons already given, we may infer that these communities, like those of Cæsar's time, were patriarchal, at least prevailingly so; but the distribution was probably no longer a yearly one. It will be noticed that two distinct procedures are described — the shifting occupation (*agri . . . occupantur*) and the shifting cultivation (*arva per annos mutant*). It is hardly possible that there could have been any shifting cultivation, that is, rotation of crops, unless the occupation was for more than one year. I think, therefore, that although not explicitly stated, it is distinctly implied, that the assignment of lands was made for a period of years, as is the case with the Russian *Mir* and the Hebrew seven-years' period. This points to a marked progress of society in the period between Cæsar and Tacitus.

In another point this progress is more positively asserted We have seen that in Cæsar's time there was not only no private property in land, but no disparity in property or in occupation. Tacitus, on the other hand, states with equal positiveness that the lands were assigned according to rank, *secundum dignationem*, that is, there was still no private property in land, but the amount of land temporarily assigned to individuals varied according to their rank. This disparity probably had reference only to the nobles and magistrates; the most of the common freemen in all likelihood received equal lots. And when, at the end of the period, the community was transferred to another tract of land, the process was begun over again. There could therefore be no aggregations of landed property, but there was a condition of things out of which such aggregations might easily grow, as soon as the occupation of a definite tract of land by a particular community should become permanent.

We find from this analysis, that in the first century after Christ, the Germans were grouped in family communities, not

yet established in permanent homes, but probably changing their residences at intervals of some years, although always within a definite territorial district. This district was, as we learn from the same authority, a permanent political institution. It follows as a matter of course that at this period there was not only no private property in land, but no common property in land, that is, no property in land at all. Neither the community nor the family *owned* the land or occupied it personally, any more than the individual. It might perhaps be urged that the district owned the territory within which the shifting occupation took place, but it may be doubted whether even this would be a correct statement of the facts. Property in land was probably a conception which lay wholly outside of their imagination as well as their experience. The land, like the air, was a free gift of nature, to be used in common, but with no thought of ownership.

As the theory of the village community implies not merely permanent occupation, but ownership of the land, on the part of the group of occupants, our conclusion must be that the village community did not exist in the time of Tacitus. Nevertheless, it must be admitted, on the other hand, that the condition of things here described is one out of which the village community could very easily have arisen. In the fact that the distribution was periodical instead of annual, we see a movement towards permanence of occupation, and therefore towards ownership, on the part of the community. The time would very soon come, in the progress of society, when the community would have accumulated so much fixed wealth in the course of its occupation, that it would be a hardship and an injustice to force it to change its habitation. The next change therefore — hardly a greater change than that from annual to periodical re-distribution — would be to convert the temporary occupancy into permanent occupancy, which means property. If this stage was reached — and it is hard to conceive of its not being reached, at least as a temporary condition of things — there resulted to village community: that is, the ownership in common of

a definite tract of land by a group of persons who were in their origin an enlarged family.

By the side of the movement towards permanency of occupation, we saw another, towards inequality of possession. The important testimony of Tacitus shows that already in his time there was, not individual property in land, or inequality of ownership, but inequality of station and of temporary occupation. Out of this would speedily be developed the inequality of property which the theory of village communities recognizes as one of the causes of the dissolution of the institution. And thus we find confirmed, from the point of view of the occupation of land, the conclusion drawn from the evidence of political and military institutions, of the development of an aristocracy of a baronial type; or, in Mr. Seebohm's words, of development on manorial lines.

NOTES ON THE DISPERSION OF DRIFT COPPER.

By Prof. R. D. Salisbury, Beloit, Wis.

Although the fact of its wide distribution has long been known, and used as evidence of the northern origin of our drift, yet no general recent compilation of the known data relating to the dispersion of drift copper seems to have been made. The study now entered upon has been undertaken at the suggestion of Prof. Chamberlin. The present paper is little more than a collection of what is to be found bearing on the subject in survey reports and scientific contributions. Frequent reference is made in geological literature to the fact that native copper has been found, and that quite generally, scattered throughout the drift region of the interior, viz.: Ohio, Indiana, Illinois, Missouri, Iowa, Michigan, Wisconsin and Minnesota, and perhaps Nebraska and Dakota. But the particulars of its occurrence, e. g., its exact localities, the size of specimens, whether or not worn and rounded, what the limits of its distribution, how abundantly the metal

is found in the formation in which it occurs, whether it is uniformly scattered, or whether there is grouping in the dispersion, whether it is in lacustrine or true drift deposits, and if in the latter, whether in modified or unmodified drift; these particulars are rarely given. An attempt to bring together and map what can be obtained from the survey reports of the several states, at once reveals the fact that the observations on this subject have been of an extremely general character. The following compilation is believed to include essentially all that has been printed, bearing on the subject.

In Ohio, Col. Whittlesey[1] has noted a specimen from Weymouth, Medina county, thirty miles south from Lake Erie. This, so far as is known, marks the eastern limit of the dispersion of copper. Again, in Clermont county, Prof. Orton, of the Ohio Survey,[2] notes the occasional occurrence of fragments of copper in the bowlder clay. Reference is also made in the Ohio reports,[3] to the frequent occurrence of copper in the drift of the northwestern part of the state, but no localities, or details as to its occurrence are given.

In Indiana, R. B. Warder, of the Indiana Survey,[4] notes a specimen found at Weisburg, in Dearborn county, on Tanner's Creek, weighing twenty-six ounces. Other specimens also have been found in the adjacent counties, Ohio and Switzerland. Still farther down, in the southwest corner of the state, in Vanderberg county, small fragments have been noted by Prof. Collett,[5] and a little to the north, the same authority notes small specimens from Knox and Brown counties. In Warren county, larger nuggets have been found, and Prof. E. T. Cox[6] is authority for the statement that some large pieces and many small ones have been found in the drift both of northern and southern Indiana.

---

[1] Smithsonian Contributions: On Fresh Water Glacial Drift of the Northwestern States.

[2] Vol. I, p. 441.

[3] Vol. I, p. 87.

[4] Indiana Geological Report, 1872, p. 403.

[5] Geological Survey, 1875, p. 284.

[6] Geological Report, 1878, p. 117.

Of the copper in Illinois we have somewhat fuller notes, though not more detailed. In this state, drift copper reaches its southern limit, so far as now known. In Saline county, near Gallatin, latitude 37° 40′, a nugget "larger than a hen's egg," with not infrequent smaller ones, have been found by Dr. Smith, and noted by Prof. E. T. Cox, then of the Illinois Survey, in the beds of streams and in ravines.[1] The same is true of Hamilton county, lying just north.

Prof. Worthen has noted the existence of copper in the drift of Clark and Cumberland counties,[2] and Mr. F. H. Bradley in Edgar, Champaign and Ford counties, lying just to the north. In Vermillion county, still further north, the same authority[3] says that several large masses of copper, and many small ones have been taken from the upper drift beds. The occurrence of copper in Hancock, Adams, Brown[4] and Schuyler[5] counties has also been noted by Prof. Worthen; and in Stephenson and Winnebago counties, where the nuggets are spoken of as much worn and rounded, and Boone, Ogle and Lee counties,[6] by James Shaw, of the Illinois survey. Woodford[7] and La Salle counties, have also yielded specimens of "float mineral," as noted by H. A. Greene. In Will county, a specimen of considerable size was found near Wilmington, probably in a lacustrine formation, while many smaller ones have been discovered both here and in Cook county.[8]

The dotted area on the map represents the area of the copper-bearing series, essentially as determined by Prof. R. D. Irving. The drift copper is represented by dots, located as exactly as the data at hand will permit. No attempt is made to show the relative sizes of the different pieces. Where the statement has been made that "float copper" is frequently found in a certain county, several dots have been placed within the limits of such county. Where but a single find has been authoritatively reported from a given district, the fact is indicated by a single dot.

[1] Vol. I. Illinois Geological Report, p. 232.

[2] Ibid., vol. VI. pp. 10 and 98.

[3] Ibid., vol. IV. p. 244.

[4] Ibid., vol. IV. p. 65.

[5] Ibid., vol. IV. p. 77.

[6] Ibid., Vol. V.

[7] Ibid., Vol. IV.

[8] F. H. Bradley, ibid., vol. IV.

In Missouri, specimens, on the authority of G. C. Brodhead, State Geologist, have been found in the eastern part of Putnam county.[1]

In Iowa, Dr. White has noted the occurence of copper in various parts of the state, and a single bowlder mass weighing upward of 30 pounds, has been taken from the drift in Lucas county.[2] In Lee and Henry counties, the occurrence of the metal in question is recorded by Prof. Worthen.[3]

In Minnesota, copper has been found in Fillmore county,[4] and at Pleasant Grove, in Olmstead county. In a description of Travers county, Mr. J. O. Barrett, speaks of its occurrence, but his language is somewhat ambiguous, and it is uncertain whether the copper referred to belongs to the county under description, or to the coteau in the adjacent part of Dakota.

Prof. G. D. Swezey, of Doane College, Nebraska, informs me that it is current report that copper has been found in small fragments in Nebraska, but he is unable to give localities.

In Michigan, a mass of copper was found at Northport, Leelenaw county, which was sold for $80, and hence must have been of great size. In Benzie, Antrim and Grand Traverse counties also, copper has been frequently met with. Col. Whittlesey speaks of a specimen the size of a man's fist, from Ada, Kent county, with frequent smaller fragments.

In Wisconsin, Dr. Lapham says[5] that in the form of drift bowlders copper is often found in eastern Wisconsin, the masses varying from a few ounces to several hundred pounds. The largest, near Huntsford, in Dodge county, had a weight of four hundred and eighty seven pounds. Prof. Chamberlin[6] states that copper is frequently found at all points along the Kettle range.

---

[1] Geological Survey of Missouri, p. 289.

[2] Vol. I, Geological Survey of Iowa, 1870, p. 96.

[3] Geological Report of Iowa, 1878, p. 178.

[4] N. H. Winchell's Report of 1875, p. 71.

[5] Wisconsin Geological Report, vol. 2, p. 27.

[6] Geological Report of Wisconsin, vol. 2, p. 210.

Prof. Irving[1] says further that fragments of copper are far more abundant in Wisconsin than elsewhere, and far more abundant here than has been commonly supposed, and that specimens of forty to fifty pounds weight are not uncommon, and have been made of economic use. It is stated by E. T. Sweet,[2] on the authority of Mr. S. Vaughan, that a copper bowlder of seventeen hundred pounds weight was formerly taken from the bed of the Sioux river, six miles south of Lake Superior, and that a bowlder of one hundred pounds weight was taken from Outer Island only a few years ago.

Col. Whittlesey[3] speaks of the copper drift in Wisconsin and northern Michigan as follows: "A copper rock weighing three thousand pounds was found in the red clay on the west fork of the Ontonagon river. One was found in 1845, opposite La Pointe, on the mainland, weighing eight hundred pounds. Three miles south of the Minnesota Mine on middle fork of the Ontonagon, another copper bowlder was taken from the red clay, which weighed between three and four hundred pounds. In a well in Madison one was found at a depth of twenty feet, having a weight of thirty pounds." At the mouth of the Menominee river a chunk three or four pounds in weight has been found, and another at the mouth of the Oconto of about the same size, while a much larger piece was taken from the Pesaukie river. In Walworth county, near the state line, Col. Whittlesey also notes a boulder of forty or fifty pounds weight. Copper has also been noticed from Ripon and Kenosha in gravel beds. In addition to these occurrences cited by Col. Whittlesey, Prof. Chamberlin has had record of about thirty specimens from Walworth county. Aside from these, one was recently found at Geneva Lake which weighed upward of seven pounds. Prof. Chamberlin is authority for the statement that a specimen of one hundred and fourteen pounds weight was taken from Newark, Rock county. This bowlder had also attached to it fragments of Lake Superior Keweenawan

[1] Wisconsin Geological Report, vol. 2, p. 619.

[2] Wisconsin Geological Report, vol 4, p. 353.

[3] Smithsonian Contributions, 1866.

rock. In Sauk and Chippewa counties, on the same authority, specimens have been found. I have picked up two specimens of copper on the shore of Lake Michigan in Ozaukee county, after a severe storm during which they were probably washed from the red clay, which there borders the lake. These specimens were both very irregular, and showed no signs of having been subjected to corrasive action.

The area over which copper is scattered is thus seen to be very great, perhaps not less than 450,000 square miles. If all the fragments came from Lake Superior, some of them must have been transported about 600 miles to the south, others, 150 or 200 miles, or perhaps more, to the west, and small specimens have been carried more than 100 miles east of the eastern limit of the locality from which the copper is supposed to have come. There is then an east-west distribution, accepting the testimony from Nebraska, of more than 700 miles, and a north-south distribution about 100 miles less.

Farther than the fact of its occurrence, however, little at present can be said of the copper in these various localities. Specimens have been found about Lake Superior and along Lake Michigan, both in Wisconsin and Illinois, in lacustrine deposits. Again, specimens have been found in bowlder clay, in lower and upper drift beds, in beds of streams and in ravines. But the character of the deposits in which the copper has been found, has, in by far the larger number of cases, not been indicated more closely than by the statement that it is drift. Pieces have been found both north and south of the kettle moraine, as well as in it. The general fact that these specimens diminish in size southward, seems to be well established, but to this there are some exceptions. Many of the nuggets are worn and rounded, but this does not seem to be universal, for angular fragments, and fragments having the irregular, scraggly form peculiar to this metal, have been found well down in Illinois. What the agency or agencies concerned in this wide spread dispersion is an interesting question. If fuller observations had been made, or if those noted had been more exact — *e. g.*, if the precise character of the formations in which the copper occurs had

been determined in each case, the size, shape and condition of the specimens, and their frequency in any locality, this might give us the data required for explaining the dispersion. There appear to be localities where the copper is more abundant than at others, as at Grand Traverse Bay, at the mouth of the Illinois river, and along the lower course of the Wabash. The seemingly greater abundance at these points, however, may only be due to fuller observation or record of the metal found at these points, and not to its really greater prevalence.

It may not be out of place to call attention to the probable fact that the Illinois river, about whose mouth many specimens have been found, was once the outlet of Lake Michigan, and that the Wabash, about whose lower course much copper has also been found, was the channel for discharge, in post-glacial times, of Lake Erie. It is evident that if the copper were all transported from Lake Superior by glaciers, they must have had, at different periods, very divergent courses to account for the east-west dispersion. The fact that copper has been found in the red clay both of Lake Superior and Lake Michigan, suggests that along the lake borders, pieces of copper may have been dropped by floating ice, and the roughness of at least a portion of the specimens here found, is in harmony with such a view.

There is of course a possibility in all cases, and this possibility may at times amount to probability, that the dispersion of copper has been by human agencies. A single loose specimen, for instance, has been found in the "driftless area" in Jo Daviess county, Illinois, in a rock crevice. But in regions where frequent specimens are found scattered through the drift, there is little probability that their occurrence can be explained by human transportation.

Dr. Bell, of the Canada Survey,[1] has described a formation on Hudson's Bay, which has a strong resemblance to our Keweenawan system. He has indicated his belief that the formation is the equivalent of the Nipigon group, which is supposed to be continuous with the Keweenawan, and, therefore, its equivalent. Dr. Bell describes copper sulphide in the as-

[1] Geological Report, 1878.

sociated formations about the Bay, but does not note native copper, which seems not yet to have been discovered. If it should be found to exist there, this would furnish a second center of dispersion, but as it is nearly north of the Lake Superior region, this would not greatly facilitate the explanation of the extensive east-west dispersion.

Fuller notes, which it is proposed to collect at an early date, will doubtless throw fuller, and, it is to be hoped, important light on the question of the dispersion of drift copper, the agency or agencies by which it was effected, and their method of action, and this solution may in turn have some bearing upon other interesting geological problems.

Since the above notes were presented in 1881, the following additional facts have been secured through the kindness of the parties to whom they are accredited. In *Ohio*, Mr. M. C. Read states that "there is an important belt of drift running through Licking, Knox and Richland counties, in which many fragments of copper have been found." Mr. C. R. Barnes reports from *Indiana*, a specimen weighing 3,125.8 grams, somewhat flattened, from Moot's Creek, White county. Another piece "four inches long by two and one-half broad, and three-fourths of an inch thick, worn smooth," was found "in glacial gravel," in Vermillion county, near Eugene (J. T. Scovell). From the same state, Mr. Joseph Moore gives information of four specimens. One was found near Richmond, Wayne county, weighing 17 oz. Another of two pounds weight was found three miles from Elkhart, Elkhart county. A third piece (mostly carbonate), has been found in Henry county, and a fourth near Brookville, Franklin county. Besides these finds, Mr. Moore also states on the authority of Mr. Farrar, that copper is frequently found about Peru, Miami county, in isolated lumps, also that a piece weighing 30 pounds was found "in shelly limestone, where they were excavating for a road." From *Michigan*, Prof. I. W. McKeever, gives information of a piece of copper from Jackson county, which the finder (Dr. Baker, of Adrian) believed to be of meteoric origin. It is claimed that it was seen while falling, and taken the next day from the opening found in the earth where the meteor was seen

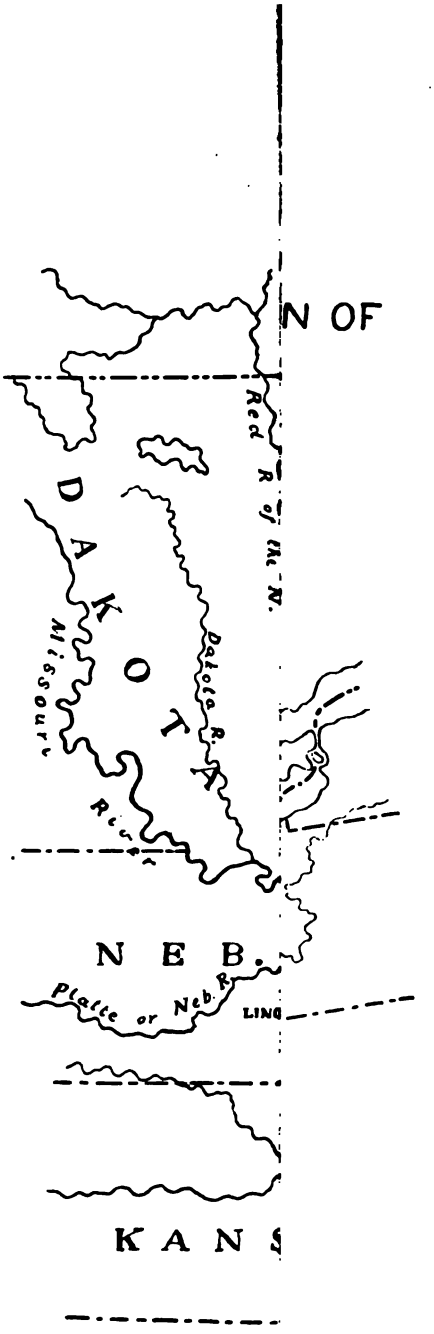
to strike. It was found eight feet below the surface. It is further asserted that "fragments of copper were found all the way down." This interesting specimen is "about two inches thick, having an area of about one square foot. It looked as if it had been melted. There were spots of green carbonate upon it," when seen by Prof. McKeever, but these, he suggests may have formed since it was found. From *Wisconsin*, Mrs. G. W. Esterley, in an article in the *Evening Wisconsin*, reports the finding of a piece of thin, flat copper insinuated among the beds of Trenton limestone, in a quarry near Lake Koshkonong. Prof. Chamberlin reports a similar case of insinuation in Galena limestone near Belvidere, Ill.

Professor H. E. Storrs writes from Jacksonville, *Illinois*, that a fragment of copper was some time since found twenty-five feet below the surface, in digging a well in that city; the same being three inches long by one and one-half broad, and one-fourth of an inch thick. The same gentleman also speaks of two other specimens of copper in his possession, weighing six and one-half ounces, and four pounds, three ounces respectively, the second being "evidently worn in transit." The precise localities of these two specimens is unknown. "A small piece of native copper was found . . . in the city of Alton, . . . in löss," according to Professor Charles Fairman, who also adds that it is locally reported that large bowlders containing copper were formerly found in that locality.

Professor N. H. Winchell, furnishes the following facts concerning drift copper in Minnesota:

State.	County.	Town.	Size of Specimens.	Condition.	Formation
Minnesota	Le Sueur	Le Sueur	?	?	?
Minnesota	Scott	Jordan	?	?	?
Minnesota	Scott	Marian	?	?	?
Minnesota	Hennepin	Minneapolis	3 pounds	Rounded.	Gravel.
Minnesota	Hennepin	Eden Prairie	78 pounds.*	.....	.....
Minnesota	Olmstead	Rochester	4 ounces	Rounded	Among stones near the rock.
Minnesota	Olmstead	Zumbrota	5 pounds	Rounded and corroded	.....
Minnesota	Olmstead	Pine Island	¾ pound	Rounded	On surface.
Minnesota	Ramsey	White Bear	2 pounds	Rounded	Near surface
Minnesota	St. Louis and Carlton	Knife Falls to N. Pacific June.	Hundreds of pieces.	?	Among stones and rounded bowlders.
Minnesota	Pine	Various places	?	?	?

* Found in a railroad cut.


N OF
Red R of the N.
DAKOTA
Dakota R.
Missouri
River
NEB.
Platte or Neb. R.
LING
KANS

ON THE MOTOR GANGLION CELLS OF THE FROG'S SPINAL CORD.

By E. A. BIRGE, Ph. D., Professor of Zoölogy, University of Wisconsin.

The following paper was originally published in the "Archiv für Anatomie and Physiologie," for 1882. A synopsis of the work is here presented in English.

The reason of our defective knowledge of even the most important numerical relations of the elementary structure of the body lies in the incomplete methods of investigation which were formerly employed. STILLING'S attempts to determine the number of the elements of the central nerves system have not been carried further, because the means of investigation were too imperfect to secure certain results even with the greatest care and industry. Rough approximations only were made, which naturally were often incorrect. The enumerations recently made of the fibers of the optic, and of certain spinal nerves have shown that the more perfect methods now at our command, have brought us nearer to accurate results.

The method of saturating the specimens with a substance which binds all parts together and gives them a like consistency, obviates one of the greatest dangers to be found in counting the cells of an organ, viz., the loss or destruction of part of the cells. Further in the possibility of staining specimens *en masse*, in perfect and rapid microtomes, in the accurate arrangement of specimens upon the slide, we have gained means which reduce to the work of a few months, tasks, for which, a decade since, a life-time would not have sufficed.

Two conditions must be fulfilled in the counting of the cells of an organ. The cells must be brought under the microscope without loss, and must be so colored that they can be at once and easily distinguished. If these conditions are met, the enumeration will be easy and quick, as well as trustworthy; but if one must deliberate whether to count certain

elements or not, the process will be exceedingly slow and wearisome, and the result thoroughly untrustworthy. Since our methods of discriminating staining are yet far from perfect, the structures capable of counting are still few. Dr. Gaule, of the Physiological Institute at Leipsic, under whose direction this paper was worked out, called my attention to two structures which filled both the above conditions, and which were of great interest. These were the medullated nerve-fibres of the anterior roots of the spinal nerves, and the large ganglion cells of the anterior horn of the gray matter of the spinal cord. The enumeration was made upon the frog, the most favorable animal, both because of its small size and because of its importance in experimental physiology.

The value of such enumerations as the following depends, of course, entirely upon their accuracy. I have attempted in every way to assure myself of the reliability of my results. The close correspondence of the number of cells found on right and left sides, seems to me the clearest proof of the accuracy of the counting.

The numbers of the elements which I have determined lead to certain conclusions, apart from any theoretical considerations. 1. The frog has an equal number of cells in the anterior horn of the spinal cord, and of fibres in the anterior roots of the nerves. Each motor cell, then, corresponds to a motor fibre. 2. There is a general correspondence between the number of cells in any region of the spinal cord and of fibres entering that region. When an individual frog shows peculiarities of distribution of fibres to different nerves there is a corresponding peculiarity in the distribution of the motor cells. It is thus probable that the ganglion cell belonging to a particular fibre lies not far from its entrance to the cord. 3. The number of fibres and cells varies with the weight of the frog. Each frog starts with a certain minimum number which is regularly increased with the increase in weight. Hence (a) the fibres and cells must be constructed during the life of the frog; (b) a certain relation obtains between the weight of the muscles and the number of the motor fibres and cells.

I. Number of Motor Fibres.

The roots were treated *in situ* with osmic acid, one per cent., for two to six hours, and imbedded in paraffine. The sections must not be over 1-100 mm. thick, better 1-200 mm., since if the axis of the fibre is not exactly perpendicular to the section the light will not pass through it unless the cylinder is very short. If the fibres overlie each other, or if they are so long that their obliquity cuts off the light, rapid and accurate counting is out of the question.

The counting was performed with an eye-piece micrometer divided into squares. Some counts were made with the camera lucida, marking each fibre by a pencil dot. This was a less accurate method. All nerves were counted twice, and the work was repeated if the difference was over two per cent.

The results are shown as follows:

TABLE I.

Number of frog	49	46	41	36	40	43	42
Weight in grammes	1¼	9¼	23	63	67	87	111
Motor fibres on one side.	2,992	3,209	3,529	4,283	4,746	5,002	5,734
Total motor fibres	5,984	6,418	7,058	8,566	9,492	10,004	11,468

The total number is reached by doubling the number obtained on one side. As will be seen later in the section on ganglion cells the number is the same on the two sides.

A somewhat regular increase of fibers proportionally to the increase of weight is seen:

TABLE II.

Frog	49	46	41	36	40	43	42
Increase of weight	.....	8	21.5	61.5	65.5	85.5	109.5
Increase of fibres.....	.....	497	1,064	2,582	3,508	4,020	5,484
Fibres per gram. of increase	.....	62	50	42	53	47	50

From this table it becomes possible to compute *a priori* the approximate number of fibres, at least for Rana esculenta. The addition of fifty fibres for each gramme in weight to the fixed number 6,000 will come near the required result. The female frogs must be weighed without ovaries.

How does this increase in number of fibres take place? It may come either by division of fibres previously present, or by new formation. The latter method is on all grounds more probable. The relative size of fibres in young and old frogs forbids us to think of division as the process, since in young frogs the fibres are of far smaller average size. This is shown by the number of fibres which stand in a given area, as the following table exhibits:

TABLE III.

	Frog 49, w't 1¼ grm.	4 23 grm.	36 63 gr.
Area of cross section of 2d motor root..	0.046 sq. mm	0.105	0.125
No. of fibres	968	1098	975
Fibres per sq. mm.	21,434	10,457	7,800

Hence the fibres in the smallest frog had hardly one-third the area of those in the larger frog. The large fibres in both are about the same size, but there are in the smaller frogs a vast number of minute fibres. There are also, probably, others not yet medullated and hence not rendered visible by osmic acid, which develop into the new nerve fibres of the older frogs.

The size of the fibres is by no means the same in the different nerves of the same frog as the following table will show:

TABLE IV.

Frog No. 36 — Wt. 63 grm.

Nerve.	I	II	III	IV	V	VI	VII	VIII	IX	X
Area of mot'r root in sq. mm.	0.087	0.125	0.052	0.018	0.024	0.0226	0.04	0.152	0.067	0.015
No. of fibres	783	975	481	106	114	159	142	870	441	212
Fibres per sq. mm	9000	7800	9257	5888	4750	7035	3550	5723	6582	14133

The differences are obvious, and unquestionably depend on the function of the nerves. The first three nerves, which supply the tongue, forward extremity, etc., have an area of

0.264 sq. mm., with 2,239 fibres, while the seventh, eighth, ninth nerves which supply the lumbar plexus, have an area of 0.259 sq. mm., with only 1,453 fibres, that is, with approximately the same area, there are only two-thirds as many fibres. The fourth, fifth and sixth nerves stand in size of fibres between the two groups, while the tenth nerve has the smallest fibres, possibly since it contains those which supply the lymph hearts.

Since the muscle fibres of the hind legs are so much larger than those of the fore legs one cannot help thinking that there is a relation between size of motor fibres and the muscle fibres supplied by them. But this question needs further investigation.

Another striking fact, like that of the size, and found also in the ganglion cells, is that of the number of fibres in brachial and lumbar plexus respectively. In spite of the smaller size of the anterior extremities they receive an equal or greater number of nerve fibres than do the hind limbs. These facts will become more apparent by the following table:

TABLE V — MOTOR FIBRES.

Number.....	49	46	41	36	40	43	42
Sex.....	—	♀	♂	♀	♀	♂	♀
Wt. in gram.	1½	9½	23	63	67	87	111
Nerve. I	359	416	652	783	754	653	1023
II	986	764	1098	975	1051	1307	1256
III	151	574	226	481	559	767	788
IV	142	155	119	106	187	146	117
V	79	96	92	114	102	118	106
VI	110	116	137	159	127	96	236
VII	135	123	137	142	162	112	141
VIII	583	309	501	870	967	446	515
IX	383	593	450	441	631	755	1248
X	64	63	112	212	206	602	310
Sum.	2992	3209	3524	4283	4746	5002	5134

The table shows that considerable individual differences are present. In No. 36 the 8th nerve has twice as many fibres as the 9th. In No. 42 the relation is reversed. Usually the 6th nerve is larger than the 5th, but occasionally the 5th is the larger, etc. The relations are more regular when groups of nerves are considered. If we neglect the contribution of the 1st nerve to the brachial plexus and that of the 10th nerve to the lumbar plexus, we have:

TABLE VI.

Number.....	49	46	41	36	40	43	42
Plexus brachialis.....	1,237	1,338	1,304	1,456	1,710	2,074	2,038
Plexus lumbalis.....	1,101	1,025	1,068	1,453	1,760	1,413	1,904

The brachial plexus contains at least as many fibres as the lumbar, and the relative size would be still more striking if the parts of the 1st and 10th nerves were assigned to their respective places.

The variation in individual nerves appears most plainly in the hinder half of the cord, and is very probably due to the relation of points of exit of nerve from cord and spinal column. When a nerve fibre has considerable distance to travel before leaving the spinal canal, it makes little difference whether it leaves the cord in one or another root. It is only necessary that it gain the proper nerve-trunk and this is determined by the plexus.

II. The Motor Ganglion Cells of the Spinal Cord.

The cords whose cells were to be counted were stained in Grenacher's alum carmine, imbedded in paraffine, and the sections cut of a uniform thickness, usually 1-50 mm. They were mounted in order and covered with xylol balsam. In this method the nerve fibres are little stained, while numerous granules and ganglion cells are tinged with a more or less deep red. In the anterior horn of the gray matter lies the group of closely-joined, large motor cells whose number is to be determined. The only difficulty in counting

lies in the presence of a number of small ganglion cells, apparently belonging to the motor center, but whose small size makes them hardly distinguishable from the "granules" of the cord. In the first frogs investigated, these cells were not counted. Later it was found that they belong to the small motor fibres and they were enumerated. In frog number eighteen, whose large cells only were first counted, the small cells were afterwards determined and about six hundred were found on each side.

The number of cells in the motor group varies in each section from 2–3 to 25–30, according to its thickness and the region of the cord to which it belonged. Single, very thin sections from the center of the cord, occasionally contain no cells.

There is no difficulty in determining with fair accuracy the number of cells, if all mechanical aids are employed, so that individual attention can be given to counting. One source or error, however, cannot be avoided. There is no natural limit to the motor center toward the medulla oblongata, but the cord gradually passes into that structure. The only fixed point is that where the spinal canal opens into the fourth ventricle, and this arbitrary line was chosen as the only one which could be determined. The following table gives the result of the counting.

TABLE VII.

Number of frog.	Total number of cells.	Right.	Left.	Difference.	Per cent. of difference.
49	4,871	2,457	2,414	43	1.8
18	6,760	3,385	3,375	10	0.3
12	6,892	3,424	3,468	44	1.3
39	8,539	4,272	4,267	5	0.1
43	11,517	5,777	5,740	37	0.6
25	11,131	5,567	5,564	3	0.1

The correspondence of the two sides is so close that it might be supposed that the exactness was attained by unconsciously following, on one side of each section, the number

found on the other. This is not the case. The cells lie in small clusters, which are seldom cut in the same position, and hence the number of cells on the two sides of the same section rarely corresponds exactly. It is therefore impossible to be influenced by the preceding counts in such a way as to "force a balance."

I add the complete enumeration of the cells of one frog, No. 43. Sections 1–146 lay in the medulla oblongata.

TABLE VIII.—No. OF CELLS.

No.	Right.		Left.		No.	Right.		Left.	
147	9		11		204	10		8	
8	10		6		5	7		12	
9	8		9		6	11	46	11	48
150	5		7		7	13		9	
1	6	38	6	42	8	7		8	
2	5		3		9	8		8	
3	6		3		210	6		10	
4	3		4		1	11	45	9	44
5	3		3		2	12		12	
6	2	19	1	14	3	11		9	
7	3		4		4	10		11	
8	4		2		5	9		10	
9	2		1		6	8	50	7	49
160	0		4		7	4		8	
1	2	11	2	13	8	11		7	
2	3		2		9	9		8	
3	7		2		220	7		8	
4	6		1		1	10	41	8	39
6	3		2		2	11		7	
6	4	23	7	14	3	7		6	
7	7		1		4	11		8	
8	3		5		5	4		12	
9	3		7		6	8	39	6	39
170	6		4		7	9		8	
1	1	20	3	20	7	8		13	
2	3		4		8	11		9	
3	4		2		9	6		10	
4	3		4		230	15	49	15	55
5	6		5		1	9		9	
6	5	21	5	20	2	11		13	
7	2		3		3	7		8	
8	5		3		4	8		6	
9	6		4		5	8	43	13	49
180	6		2		6	11		12	
1	7	26	5	17	7	8		7	
2	6		5		8	13		10	
3	5		5		9	7		7	
4	6		6		240	8	47	6	42
5	6		9		1	9		11	
6	3	26	8	33	2	10		13	
7	4		8		3	9		12	
8	4		5		4	13		5	
9	1		4		5	8	49	20	61
190	3		5		6	21		9	
1	4	16	1	23	7	23		10	
2	3		5		8	18		11	
3	8		6		9	8		12	
4	7		9		250	10	80	16	58
5	10		11		1	11		16	
6	12	40	9	40	2	9		14	
7	6		7		3	17		7	
8	7		10		4	19		14	
9	11		6		5	19	75	11	62
200	9		7		6	12		13	
1	9	42	9	39	7	10		17	
2	10		9		8	13		12	
3	8		8		9	16		19	

TABLE VIII. — NO. OF CELLS — Continued.

No.	Right.		Left.		No.	Right.		Left.	
260	17	68	18	79	315	13	73	19	72
1	13		11		6	14		13	
2	15		17		7	10		12	
3	18		12		8	14		16	
4	15		13		9	13		14	
5	11	72	17	70	320	12	63	7	62
6	15		15		1	15		18	
7	10		11		2	11		12	
8	19		12		3	13		9	
9	12		11		4	18		11	
270	7	63	9	58	5	22	79	15	65
1	12		12		6	16		12	
2	11		12		7	12		15	
3	11		8		8	14		12	
4	7		12		9	13		9	
5	19	60	16	60	330	9	64	12	60
6	8		9		1	17		16	
7	10		11		2	15		18	
8	13		8		3	13		10	
9	15		16		4	8		14	
280	8	54	10	54	5	12	65	13	70
1	14		12		6	23		18	
2	11		10		7	18		11	
3	14		8		8	12		8	
4	11		9		9	17		12	
5	10	60	10	49	340	12	77	18	67
6	12		15		1	13		19	
7	13		21		2	15		11	
8	12		10		3	21		18	
9	19		17		4	16		11	
290	11	67	20	83	5	14	79	13	72
1	12		18		6	19		14	
2	11		12		7	12		16	
3	9		13		8	13		11	
4	9		12		9	12		11	
5	10	51	16	71	350	9	65	12	64
6	15		18		1	15		23	
7	10		17		2	13		11	
8	12		8		3	12		10	
9	10		14		4	11		10	
300	9	56	12	69	5	15	66	14	68
1	17		15		6	15		12	
2	9		10		7	17		15	
3	8		13		8	11		13	
4	12		10		9	10		14	
5	10	56	9	57	360	12	65	8	62
6	9		19		1	13		13	
7	11		16		2	15		11	
8	7		17		3	18		15	
9	12		11		4	9		17	
310	13	52	12	75	5	18	73	13	69
1	13		17		6	9		10	
2	16		12		7	17		12	
3	14		11		8	24		17	
4	17		23		9	22		15	

TABLE VIII. — NO. OF CELLS — Continued.

No.	Right.		Left.		No.	Right.		Left.	
370	12	84	13	67	424	8	34	9	39
1	15		17		5	6		5	
2	14		20		6	7		12	
3	11		13		7	5		3	
4	14		17		8	4		4	
5	10	64	8	75	9	7	30	3	27
6	17		17		430	8		4	
7	11		10		1	5		9	
8	12		18		2	6		4	
9	18		20		2′	5		2	
380	11	69	12	77	3	6	31	4	23
1	17		16		4	4		6	
2	8		13		5	5		7	
3	11		16		6	6		5	
4	12		11		7	4		7	
5	6	54	5	61	8	5	25	6	31
6	4		9		9	2		2	
7	5		8		440	4		3	
8	8		12		1	7		4	
9	9		7		2	5		6	
390	8	34	10	46	3	0	23	6	21
1	7		8		4	6		2	
2	6		5		5	7		5	
3	5		7		6	3		5	
3′	9		5		7	6		8	
4	6	33	4	29	8	6	22	3	23
5	7		7		9	3		7	
6	3		4		450	3		2	
7	9		8		1	2		5	
8	7		9		2	4		2	
9	5	31	7	35	3	6	18	3	19
400	4		3		4	4		5	
1	7		8		5	7		3	
2	4		6		6	6		4	
3	8		3		7	6		4	
4	4	27	3	23	8	5	29	4	20
5	5		4		9	4		6	
6	6		4		460	5		3	
7	2		4		1	5		9	
8	6		8		2	5		6	
9	3	22	5	25	3	3	24	3	27
410	4		5		4	4		4	
1	3		7		5	6		5	
2	4		5		6	3		2	
3	6		2		7	3		2	
4	3	20	5	25	8	4	21	1	14
5	10		6		9	2		1	
6	7		4		470	1		3	
7	6		5		1	5		2	
8	7		7		2	3		5	
9	5	35	6	28	3	3	14	2	13
420	9		12		4	3		6	
1	10		8		5	2		5	
2	14		6		6	4		3	
3	7		4		7	3		2	

TABLE VIII — NO OF CELLS. — Continued.

No.	Right.		Left.		No.	Right.		Left.	
478	2	14	2	18	538	4	25	5	28
9	0		3		4	4		6	
480	2		5		5	5		3	
1	6		2		6	4		6	
2	5		3		7	5		3	
3	5	18	3	16	8	2	20	4	22
4	6		4		9	4		4	
5	4		4		540	7		5	
6	2		1		1	3		5	
7	4		8		2	6		7	
8	5	21	5	20	3	6	26	6	27
9	5		6		4	3		4	
490	4		5		5	3		2	
1	3		6		6	4		9	
2	1		3		7	3		0	
3	5	18	4	24	8	4	17	5	20
4	6		5		9	6		5	
5	6		4		550	8		9	
6	3		6		1	8		5	
7	5		3		2	4		7	
8	3	23	3	21	3	6	32	5	31
9	5		3		4	7		6	
500	2		7		5	5		6	
1	4		6		6	8		7	
2	5		2		7	6		8	
3	6	22	4	22	8	4	30	4	31
4	5		4		9	5		7	
5	6		3		560	7		4	
6	6		8		1	3		4	
7	7		4		2	5		10	
8	2	26	3	22	3	7	27	8	33
9	5		4		4	5		4	
510	3		5		5	5		6	
1	6		3		6	4		6	
2	3		5		7	5		3	
3	9	26	5	21	8	4	23	5	24
4	8		4		9	6		6	
5	5		6		570	5		4	
6	7		8		1	3		6	
7	6		9		2	5		6	
8	7	34	6	33	3	5	24	3	25
9	5		6		4	2		4	
520	8		5		5	4		3	
1	10		12		6	5		7	
2	8		5		7	5		4	
3	7	38	10	38	8	6	22	3	21
4	9		5		9	4		2	
5	6		5		580	5		3	
6	6		7		1	4		3	
7	8		6		2	3		2	
8	5	34	5	28	3	2	18	4	14
9	5		6		3	3		3	
530	6		4		5	2		2	
1	5		8		6	1		2	
2	5		5		7	3		4	

TABLE VIII.—NO. OF CELLS.—Continued.

No.	Right.		Left.		No.	Right.		Left.	
588	4		3	14	641	11		9	
9	2		5		2	6		5	
590	4		2		3	9	38	7	38
1	1		4		4	8		5	
2	4				5	6		5	
3	5	16	2	16	6	7		8	
4	2		3		7	6		5	
5	4		3		8	7	34	10	33
6	1				9	5		8	
7	2		2		650	6		5	
8	1	10		8	1	7		5	
9	3		4		2	8		7	
600	2		4		3	6	32	5	30
1	7		2		4	10		9	
2	1		3		5	6		7	
3	4	17	3	16	6	6		4	
4	2		4		7	9		6	
5	3		3		8	6	37	8	34
6	5		2		9	5		9	
7	4		5		660	8		7	
8	2	16	3	17	1	10		9	
9	5		5		2	5		8	
610	3		5		3	4	32	7	40
1	5		7		4	6		15	
2	2		3		5	4		5	
3	4	19	6	26	6	3		5	
4	3		4		7	4		3	
5	2		2		8	3	20	5	33
6	3		2		9	5		7	
7	3		2		670	3		2	
8	6	17	8	18	1	2		5	
9	7		8		2	4		4	
620	7		9		3	0	14	6	24
1	8		9		4	4		7	
2	7		8		5	3		2	
3	8	37	9	43	6	5		2	
4	11		9		7	3		6	
5	9		16		8	7	20	6	23
6	6		7		9	3		3	
7	4		9		680	2		5	
8	8	38	6	41	1	4		9	
9	5		7		2	3		2	
630	10		9		3	5	27	3	22
1	5		8		4	6		4	
2	8		9		5	5		4	
3	7	35	6	39	6	3		5	
4	11		8		7	5		6	
5	10		9		8	6	25	6	25
6	9		10		9	7		8	
7	7		6		690	6		6	
8	6	43	8	41	1	4		7	
9	7		10		2	9		6	
640	5		7		3	7	33	8	35

TABLE VIII.—NO. OF CELLS—Continued.

No.	Right.		Left.		No.	Right.		Left.	
694	5		6		749	12		8	
5	5		7		750	6		11	
6	8		8		1	10		10	
7	5		4		2	9		12	
8	9	32	10	35	3	10	47	13	54
9	5		7		4	11		15	
700	8		4		5	6		11	
1	8		9		6	10		11	
2	7		6		7	13		16	
3	6	34	6	32	8	9	49	5	58
4	7		5		9	6		6	
5	4		9		760	15		13	
6	9		8		1	9		11	
7	8		5		2	8		5	
8	6	34	8	35	3	9	47	8	43
9	4		9		4	14		16	
710	5		3		5	13		12	
1	8		3		6	13		11	
2	4		6		7	6		6	
3	7	28	5	26	8	10	56	14	59
4	6		5		9	8		7	
5	4		9		770	9		10	
6	5		3		1	8		8	
7	4		4		2	5		4	
8	3	22	6	27	3	14	44	12	41
9	5		4		4	9		11	
720	13		12		5	5		6	
1	9		6		6	14		11	
2	7		10		7	8		5	
3	11	45	6	38	8	9	45	8	41
4	6		5		9	10		13	
5	10		13		780	11		9	
6	9		11		1	18		18	
7	8		14		2	7		6	
8	10	43	11	54	3	10	56	11	57
9	6		10		4	8		6	
730	6		8		5	9		9	
1	7		8		6	10		9	
2	7		7		7	16		8	
3	1	37	9	42	8	7	50	8	40
4	9		8		9	11		10	
5	9		10		790	9		5	
6	6		7		1	7		8	
7	12		10		2	9		11	
8	5	41	9	44	3	10	46	14	48
9	6		11		4	12		7	
740	9		10		5	6		6	
1	10		4		6	17		11	
2	9		8		7	17		18	
3	8	42	8	41	8	9	61	6	48
4	7		6		9	8		12	
5	6		5		800	5		9	
6	11		9		1	7		11	
7	5		9		2	9		9	
8	8	37	9	38	3	8	37	5	46

TABLE VIII.—NO. OF CELLS.—Continued.

No.	Right.		Left.		No.	Right.		Left.	
804	9		8		845	10		11	
5	9		4		6	11		12	
6	7		6		7	10		10	
7	8		5		8	11	50	7	47
8	9	42	7	30	9	11		12	
9	8		10		850	13		7	
810	11		10		1	13		14	
1	8		7		2	12		14	
2	9		6		3	8	57	10	57
3	13	49	12	45	4	12		8	
4	10		13		5	10		14	
5	9		6		6	18		6	
6	5		7		7	7		8	
7	6		6		8	10	57	8	44
8	9	39	10	42	9	7		11	
9	8		9		860	8		12	
820	7		10		1	6		5	
1	14		10		2	7		6	
2	9		12		3	9	37	4	38
3	16	54	10	51	4	8		7	
4	11		8		5	6		5	
5	9		11		6	8		4	
6	10		13		7	6		5	
7	12		14		8	3	31	3	24
8	14	56	18	64	9	4		6	
9	16		18		870	3		5	
830	10		20		1	3		4	
1	15		8		2	5		6	
2	14		12		3	2	17	2	23
3	16	71	17	75	4	4		3	
4	15		11		5	1		0	
5	10		7		6	3		1	
6	8		10		7	2		2	
7	9		8		8	0	10	1	7
8	17	59	13	49	9	2		0	
9	12		10		880	4		3	
840	13		11		1	2		2	
1	11		14		2	1		0	
2	6		9		3	0	9	0	5
3	8	50	5	49	4	1		1	
4	8		7		5	2		1	

The addition of all the cells gives 5,777 for the right side 5,740 for the left side, as in table I. It will be seen that the numbers in the same section usually differ and often considerably, while each group of five sections or one-tenth mm. shows a closer corrrespondence.

The total number of the cells varies in proportion to the weight of the frog as shown by

TABLE IX.

Number of frog	49	18	12	36	42	25
Weight in grammes	1½	22	44	68	111	115
Number of cells	4,871	6,760	6,882	8,539	11,517	11,187

In Nos. 12 and 25 only the large cells were counted and tho numbers are therefore too small. Nos. 49, 18 and 43 are male, 12, 14 and 25 female. The ovaries were removed from the latter before weighing. Hence we may conclude that there is a relation between weight and number of ganglion cells not unlike that which obtains between weight and motor nerve fibres.

In the brachial region the cells are distributed in small layers, each only one cell thick, and the spaces between the layers are occupied by the outgoing fibres. In the lumbar region no such arrangement is visible. The motor fibres of the brachial region pass off at right angles to the cord, and in the same way from the motor centre, while those of the lumbar region pass off obliquely both inside and outside of the cord. The most convenient method of showing the distribution of the cells is, therefore, that of taking a unit of space and showing the number of cells in that. I have chosen one-tenth mm. as the space since it is small enough to show the influence of the nerves and large enough to eliminate differences in thickness of the sections. I give the result in tabular form and graphically in plates I and II which are to be compared with the tables.

TABLE X.

Frog No. 49. Weight 1½ grm. No. of cells in each one-tenth mm. See Plate I, Fig. I.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	35	42			25	35	
	37	43			35	32	
	51	51			21	21	
	68	72			26	26	
	89	98			30	32	
	192	137			43	52	
	104	108			52	56	
	90	96			53	53	
	114	131			68	71	
859	129	119	897	431	78	89	467
	129	111			85	75	
	100	89			83	72	
	33	33			87	101	
	26	28			88	97	
	38	22			94	87	
	22	16			95	87	
	26	21			83	80	
	16	19			54	55	
	24	27			29	28	
419	24	25	401	705	7	9	692
				2,414			2,547
						Total.	4,871

TABLE XI.

Frog No. 18. ♂ Weight 22 grm. Plate I, Fig. II.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	43	45			24	27	
	70	70			22	23	
	63	55			23	22	
	56	55			29	19	
	58	60			22	20	
	63	65			24	31	
	79	69			26	25	
	71	83			30	32	
	83	70			39	35	
667	81	82	654	268	29	32	266
	82	78			34	31	
	84	79			34	30	
	69	75			32	41	
	80	83			38	39	
	72	73			48	54	
	78	73			54	57	
	79	83			45	42	
	76	83			49	51	
	74	71			49	49	
751	47	56	754	429	46	39	433
	28	20			52	47	
	23	25			55	50	
	27	32			50	60	
	33	32			66	54	
	24	20			57	61	
	21	20			59	60	
	24	25			56	55	
	19	15			54	65	
	28	33			60	67	
252	25	23	245	576	63	66	585
	24	29			69	62	
	17	17			56	67	
	24	27			45	69	
	21	28			14	22	
	20	28			6	6	
	29	22			6	5	
	26	25					
	27	26					
	21	23					
237	28	20	245	195			201
				3,375			3,383
						Total..	6,758

TABLE XII.

Frog No. 36. Weight 67 grm. Plate I, Fig. III.

n.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	7	11			21	24	
	11	19			18	21	
	32	37			16	13	
	22	35			21	15	
	31	34		214	24	20	197
	40	42			27	26	
	50	45			17	17	
	60	72			25	25	
	59	56			17	21	
8	46	52	403		21	24	
	42	39			20	26	
	40	37			26	27	
	52	54			18	18	
	74	64			10	19	
	62	65		198	17	30	233
	65	69			29	30	
	79	81			22	23	
	81	75			25	29	
	66	62			17	24	
5	64	73	619		26	25	
	62	72			21	33	
	74	74			32	29	
	64	57			17	20	
	62	61			21	21	
	65	69		232	21	21	255
	68	73			16	25	
	77	70			31	30	
	85	87			31	23	
	65	72			31	31	
8	86	69	704		37	37	
	73	71			35	33	
	76	69			45	37	
	78	73			46	45	
	53	50			63	58	
	56	46		396	61	56	375
	27	23			61	67	
	27	29			64	65	
	34	25			55	51	
	21	21			52	46	
5	20	24	440		52	49	
	24	26			55	43	
	27	26			45	45	
	23	20			41	39	
	23	25			34	43	
	35	26		487	28	32	480
	20	23			30	31	
	16	21			29	32	
	14	17			40	37	
	23	24			37	34	
6	21	20	228		40	38	
	23	16			44	41	
	29	23			33	34	
	23	19			36	38	
	22	30			23	25	
	17	17		343	21	13	323

TABLE XII. — Continued.

Sum.	Right.	Left.	Sum.	Sum.	Left.	Right.	Sum.
	6	5			1	1	
	2	3					
	2	4		'15			16
	3	0					
	2	1		4267			4272
					Total	8539	

TABLE XIII.

Frog No. 42. Weight. 111 Grm. See Plate II, Fig. IV.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	38	42		607	33	29	618
	19	14			31	35	
	11	18			27	23	
	23	14			22	25	
	20	20			20	25	
	21	20			35	28	
	26	17			34	39	
	26	33			30	27	
	16	23			31	23	
240	40	40	236		25	31	
	42	39		278	23	21	277
	46	48			22	23	
	45	44			18	19	
	50	49			29	20	
	41	39			24	27	
	39	39			21	14	
	49	55			14	13	
	43	49			14	18	
	47	42			18	16	
451	49	61	466		21	20	
	80	58		199	18	24	194
	75	62			22	22	
	68	79			26	22	
	72	70			26	21	
	63	58			34	33	
	60	60			38	38	
	54	54			34	28	
	60	49			25	28	
	67	83			20	22	
650	51	71		274	26	27	262

TABLE XIII.—Continued.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	56	69			17	20	
	56	57			32	31	
	52	75			30	31	
	73	72			27	33	
	63	62			23	24	
	79	65			24	25	
	64	60			22	21	
	65	70			18	14	
	77	67			13	14	
664	79	72	669	222	16	16	229
	65	64			10	8	
	66	68			17	16	
	65	62			16	17	
	73	69			19	26	
	84	67			17	18	
	64	75			37	43	
	69	77			38	31	
	54	61			35	39	
	34	46			43	41	
270	38	38	287		56	59	
	34	33			44	41	
	32	30			45	41	
	37	34			56	57	
	32	40			50	48	
	20	33		477	46	40	479
	14	24			61	48	
	20	23			37	46	
	17	22			42	30	
	25	25			49	45	
264	33	35	299		39	42	
	32	35			54	51	
	34	32			56	64	
	34	35			71	75	
	28	26			59	49	
	22	27		518	50	49	
	45	38			50	47	
	43	54			57	57	
	37	42			57	44	
	41	44			37	38	
358	42	41	374		31	24	
	37	38			17	23	
	47	51			10	7	
	49	58		268	9	5	245
	47	43		5,740			5,777
						Total	11,517

TABLE XIV.

Frog No. 25. ♂ Weight 115 grm. See Plate II, Fig. V.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	23	25			21	21	
	18	20			16	16	
	24	22			23	17	
	32	31			16	14	
	32	35		209	22	23	204
	44	40			20	25	
	50	45			21	18	
	56	49			23	23	
	65	65			25	25	
438	94	76	408		23	28	
	64	64			26	26	
	64	61			29	26	
	58	50			21	25	
	60	51			22	20	
	38	53		229	19	19	235
	39	39			27	24	
	41	62			18	17	
	57	73			27	25	
	56	65			15	18	
547	70	71	589		18	12	
	76	75			16	20	
	90	100			13	19	
	74	72			11	12	
	77	82			18	25	
	79	76		183	20	19	192
	90	91			33	35	
	84	78			37	36	
	77	67			37	34	
	75	66			28	32	
789	67	84	791		37	37	
	77	59			45	36	
	62	58			38	37	
	67	71			41	34	
	65	60			34	30	
	67	59		364	34	34	345
	83	77			36	39	
	62	62			23	32	
	66	73			33	34	
	64	68			32	36	
685	72	70	648		34	32	
	73	69			45	47	
	54	48			38	40	
	39	31			34	38	
	33	26			42	44	
	28	30		360	43	33	375
	18	18			43	35	
	17	19			36	33	
	14	18			34	33	
	21	20			38	36	
314	17	15	294		45	44	
	28	34			44	53	
	25	17			51	47	
	17	21			31	42	
	20	21			57	55	
	21	20		429	50	52	430

TABLE XIV.—Continued.

n.	Right.	Left.	Sum.	Sum.	Right.	Left.	Sum.
	44	47			22	20	
	68	70			16	14	
	60	62		383	4	9	417
	58	63			9	10	
	54	55			7	8	
	56	64			3	3	
	54	61			5	3	
	53	45			4	4	
	75	63			3	2	
4	72	68	598		2	2	
	62	70			2	2	
	58	70			1	1	
	54	65		38	2	3	38
	48	52			1	0	
	43	49			1	1	
	44	41		5,564			5,567
	32	27				Total.	11,131

we consider the tables, or better, the plates, we shall see ; the cells are arranged in two great groups, correspond- to the brachial and lumbar enlargements, which are con- ted by the slender dorsal region. We can then divide the al cord into three regions—one for the 1st–3d nerves, second for the 4th–6th nerves, and the third for the 7th– nerves. We will consider each separately:

TABLE XV.

f Frog....	49	18	12	36	25	42
of brachial region.....	2076	2828	3204	4061	5306	5104
l Cells.....	4871	6758	6892	8539	11131	11517
cent. of cells in brachial re- on.....	44.6	41.6	46.8	47.5	47	45.1

he length of this region does not correspond to the num- of cells, as seen by

TABLE XVI.

No. of Frog	49	18	36	25	42
Length of cord, mm	4.1	7.6	11.6	13.9	14.7
Length of brachial region	1.2	2	3.5	4	4.8
Per cent. of total length	29.2	26.3	30.1	31.6	32.7

The cell-bearing part of the cord, only, is measured, and the table shows that the cells lie far closer in the brachial region than in the succeeding ones. It is also plain that there is no correspondence between the outside measurement of diameter of cord, or of the gray matter, and the number of cells contained.

It is further noticeable that the cells are very regularly distributed in the brachial region. There is a sudden rise in number, a tolerably regular maintenance of a maximum, and a rapid diminution at the close of the region. This fact is due to the direction of exit of the fibres, it being, as before said, at right angles to the cord. Part of the third ne v indeed passes forward and so serves to still more clearly mark the line between the first and second regions. It is not easy to draw a line between the second and third regions. In both the nerves pass off obliquely, and the roots overlap each other in such a way that no sharp rise is seen and no line of division can be drawn.

The two posterior regions together contain, in percentages, the following number of cells.

TABLE XVII.

Number of Frog	49	18	12	36	25	42
	55.3	58.3	53.2	52.5	52.9	54.9

In the second region it is not possible to find, in most cases, enlargements corresponding to the nerves. The cells are pretty evenly distributed.

In the third region several facts are noticeable:

1. The small number of cells in proportion to the weight of muscle supplied. The weight of the leg muscles is far greater than that of the arm muscles, but the ganglion cells, though larger are scarcely more numerous. The fibres of the muscles are much larger in the leg, and of course, investigation should turn on the relation of number of cells to fibres. This has not been worked out.

2. The cells increase gradually to a maximum and very rapidly fall off in number at the rear end.

3 The position of the maximum is variable and probably depends on the relative size of the nerves going into the lumbar plexus. This is well seen in Frog No. 43, where both fibres and cells were counted. An unusually large 10th nerve was found and the maximum of cells is unusually far back. In general the maximum lies near the exit of the 8th nerve.

4. It may be inferred that the nerve fibres do not go far in the cord before uniting with a cell.

5. There is a long string of scattered cells at the posterior end often ½ mm. long.

The exact relation of the maxima of cells to the points of exit of the nerves is not easy to determine on cross sections which alone I have studied. The third nerve passes as already said, forward, and the roots of the posterior nerves overlap. Longitudinal sections prepared by other methods will give conclusions on this point.

A word may be said on the relation of length of cord and number of cells, though no proportional relation was found.

TABLE XVIII.

Frog, No.	49	18	36	25	42
Length of cord, mm.	4.1	7.6	11.6	13.9	14.7
No. of cells	4871	6758	8539	11131	11517
Cells per mm	1189	905	636	800	783

It is plain that the length increases more rapidly than the number of the cells. The length is necessarily taken from

the imbedded cord. Proportional results are probably not impaired by this fact, although the exception to the series seen in No. 36 may rest on some irregularity in shrinking during imbedding.

A comparison of cells per mm. in brachial and lumbar regions may be interesting.

TABLE XIX.

Frog, No.	49	36	42
Weight of frog, grammes	1½	67	111
Cells, per mm. brachial	1780	1160	1063
Cells, per mm. lumbar	1352	791	784

The cells lie more closely than in the brachial region, and the number of cells decreases per mm. with the growth of the frog more rapidly in the lumbar than in the brachial region. This fact is plain also in the outer form of the cord which gradually changes from a conical to a cylindrical form. The change is also more rapid in youth than later.

III. Relation of Motor Cells and Fibres.

In frog No. 42, the motor fibres of the right side and the cells were both counted as given in the preceding pages.

The number of motor fibres in the ten nerves on the right side was 5,734.

The number of ganglion cells was, right, 5,777; left, 5,740. The correspondence is so close that we can well conclude that for each motor nerve fibre there is present a ganglion cell in the anterior horn of the cord, and that all ganglion cells therein contained are connected with motor nerve fibres.

Other countings gave the following result:

TABLE XX.

No. of Frog	49	36	42
Motor Fibres of one side	2,992	4,283	5,734
Ganglion Cells of right side	2,457	4272	5,777
Difference	+535	+43	−43

The great difference between the fibres and cells of frog 49, was a surprise to me. It is, however, easily explained. As already said, the nervous elements in a small frog are smaller than in the larger ones. There are thus a larger number proportionately of small cells and fibers. But while osmic acid discriminates easily from the smallest fibres, the corresponding cells are hardly distinguishable from the large embryonic cells found in great numbers in the cord of developing frogs, like the one in question. I therefore suppose that the number given for the fibres is probably the true number for the cells.

I append a figure in which the weight of the frog serves as the axis of abscissas, and the number of ganglion cells and nerve fibres as that of ordinates. It will be seen that there is quite a close correspondence between the lines of cells and and fibres, but that the former shows a too cupid decline in the region of the smaller frogs. The lines should probably run parallel and would do so were the methods for discriminating cells as good as those for fibres.

In Fig. 1 the figures on the lower side of the cut represent the weight of the frogs in grammes; those on the right of the cut, the number of cells or fibres. The broken line represents the curve of the ganglion cells. The upper line shows the nerve fibres, and the lower line the large ganglion cells in those frogs where only those cells were counted. The numbers in the cut refer to those of the frogs examined.

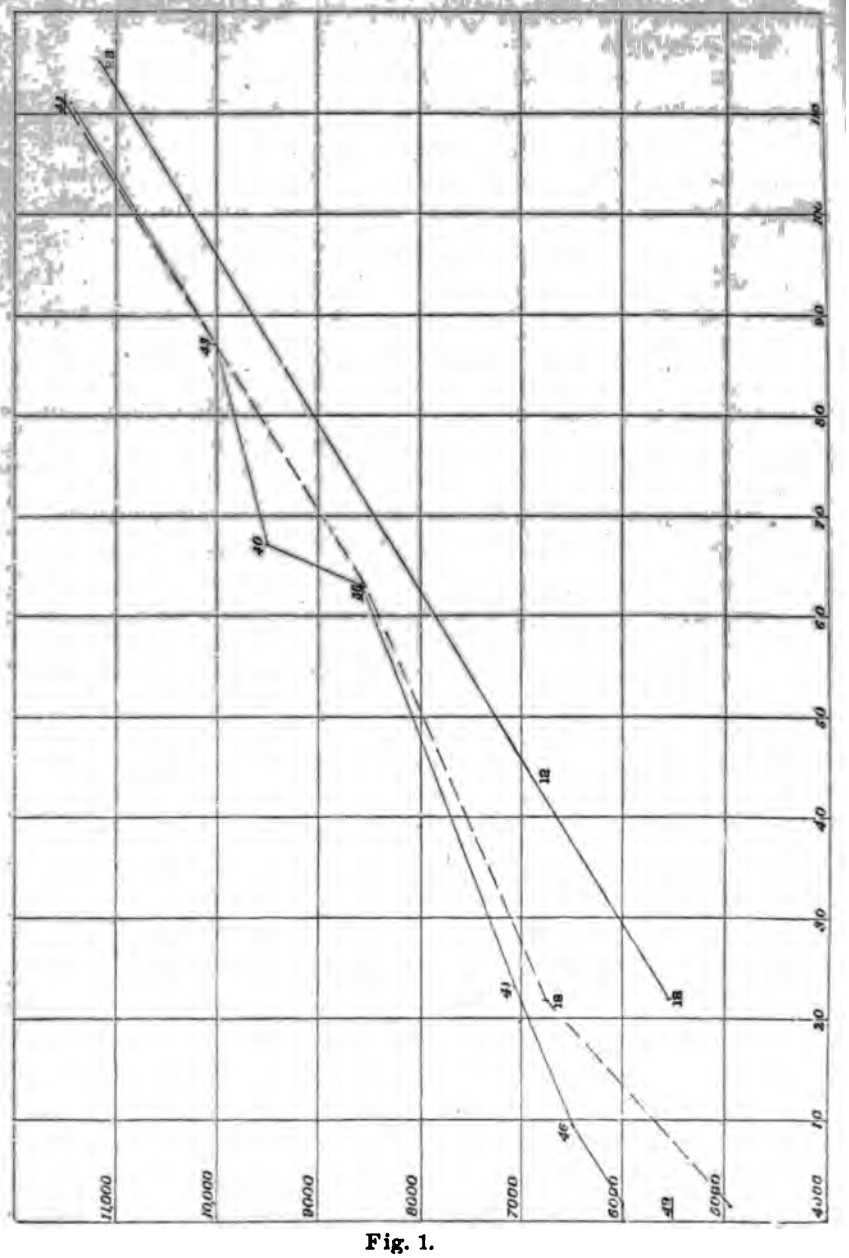

11000
10,000
9000
8000
7000
6000
5000
4000
10
20
30
40
50
60
70
80
90
100
110
12
13
41
46
40
43
45

Fig. 1.

It remains to briefly consider the relation of the fibres and cells of different regions.

TABLE XXI.

Frog No.	36	42
Fibres, Nerves 1–3	4578	6122
Cells of brachial region	4061	5104
Difference	—517	—1018
Fibres, Nerves 4–10	4088	5346
Cells of dorso-lumbar region	4478	6423
Difference	+390	—1067

The table shows that we have too many cells in the dorso-lumbar region, too few in the brachial. The latter must therefore draw on the former, and, as already remarked, there are ascending fibres from the middle region of the cord.

We can also determine the point where the supply for the lumbar plexus begins.

The first six nerves contain in Frog 36, 5236 fibres, in 42, 7040. In figures II and III this point is marked with *d*, a point in the middle region just above the lumbar enlargement. This confirms previously advanced views.

IV. Number of Sensory Fibres.

The following table gives the facts so far as I have investigated them.

TABLE XXII.

	No. 41, ♂ Wt. 23 Gr.				No. 36. ♀ Wt. 63 Gr.			
Nerve.	Motor.	Sensory.	Sum.	Trunk.	Motor.	Sensory.	Sum.	Trunk.
I.	652	78	720	718	783	124	907	908
II.	1098	1230	2328	2563	975	1649	2624	3041*
III.	226	143	369	370	481	264	745	749
IV.	119	185	304	301	106	193	299	297
V.	92	188	280	279	114	224	338	339
VI.	137	176	313	314	159	184	343	341
VII.	137	470	608	607	142	562	704	703
VIII.	501	737	1238	1243	870	1101	1971	1955
IX.	450	547	997	1001	441	993	1434	1633*
X.	112	27	139	141	212	41	253	253
Sum.	3524	3781	7295	7325	4283	5335	9618	

It will be seen that except in two cases there is a close agreement between the sum of the roots and the trunks. In those two cases the nerve was so large as to be unstained near its exit from the spinal column, and sections were taken lower down, where the nerve may have been joined by other nerves.

It is plain, (1) that the number of motor fibres is smaller than that of the sensory; and (2), if these two frogs may be taken as examples, that the number varies with the weight of the frog, but not according to the same law as do the motor fibres.

V. Functions of the Motor Ganglion Cells.

Experiments were made with a view of directly determining the function of the group of cells whose numbers were counted. The frog's brain was destroyed and the spinal cord exposed. It was then fastened on a plate like the mechanical stage of a microscope, and its tendo achillis was connected with a registering drum in the usual way. A very fine needle was plunged into the cord by means of a rack-and-pinion movement. It was first inserted into the center of the cord, then withdrawn, the frog was moved one-tenth mm. and the cord again pierced, the needle withdrawn, and the operation was repeated until the whole breadth of cord was passed below the needle. The usual effect of the prick was either nothing or a twitch of the muscle; at one point, however, a tetanus was produced. To determine this point the cord was hardened, imbedded, and a section made at the point experimented upon; a drawing of the section was then divided into as many equal spaces as there had been needle pricks, and it was found that *those pricks which caused a tetanus passed through or close to the group of large ganglion cells.* This was the case whether the cord was pierced from the side or from above. We may then conclude that these ganglion cells have the power of converting into a tetanus, a stimulus which, if applied to the nerve would cause merely a single twitch.

Explanation of Plates.

Plates I and II are a graphic representation of the tables X–XV., and show the number of cells for each one-tenth mm. of length of spinal cord. The vertical line marked O serves as the axis of abscissas and contains as many units of length as does the given cord one-tenth mm. On each side are ordinates erected whose length corresponds to the number of cells at the given horizon. Each space on this axis stands for ten ganglion cells. The figures are placed vertically so as better to show the right and left, anterior and posterior directions of the cord. In Fig. IV. the points of exit of the nerves are marked.

One source of error in the plates should be noted. It is assumed that the sections were cut at right angles to the spinal cord. Since this is never exactly true it happens that a small bilateral asymmetry exists in the figure which may not be found in the cord.

Fig. I. see Table X., page 67.
Fig. II. see Table XI., page 68.
Fig. III. see Table XII., page 69.
Fig. IV. see Table XIII., page 70.
Fig. V. see Table XIV., page 72.

Fig. III.

Number of Cells in 1/10 mm.

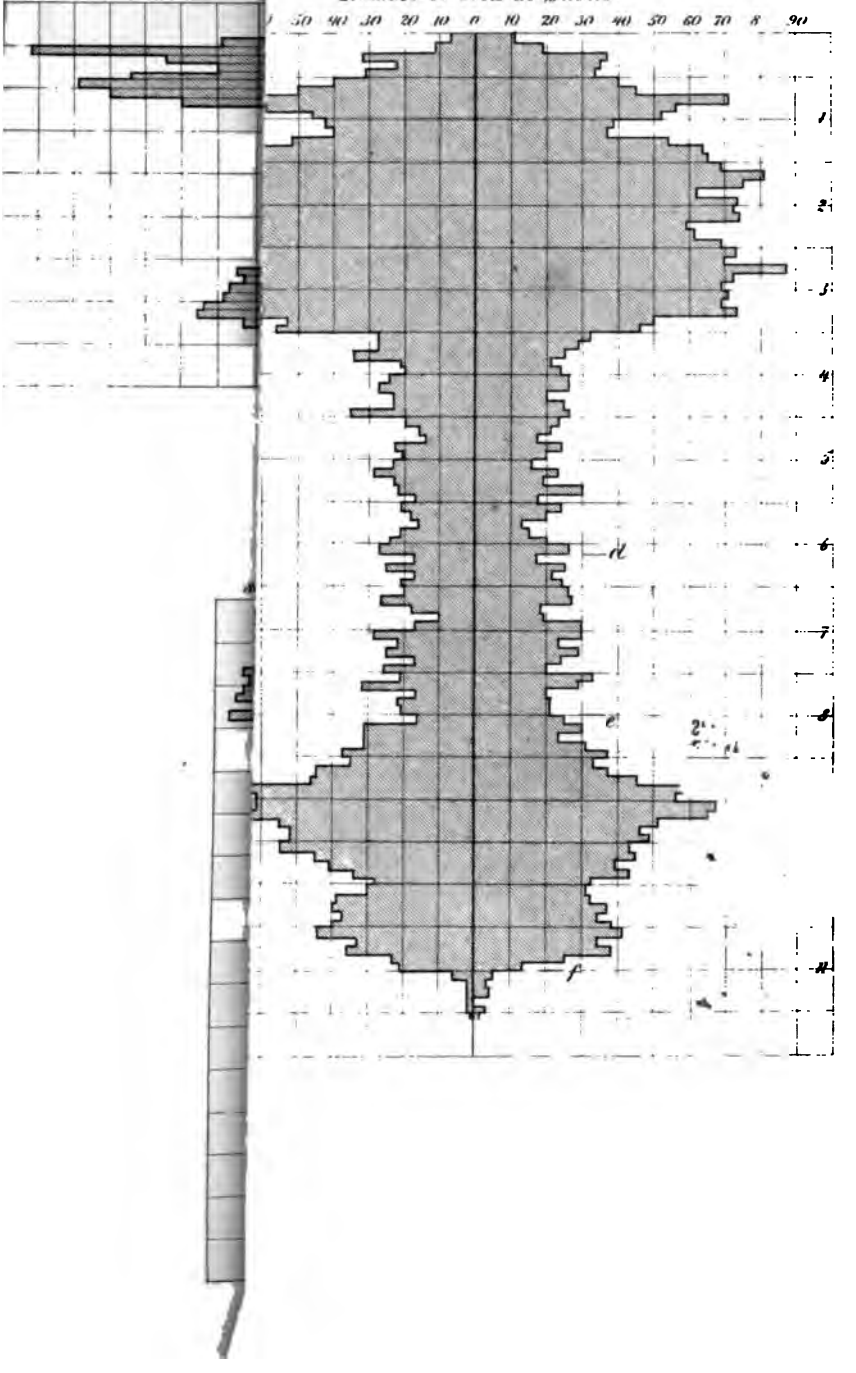
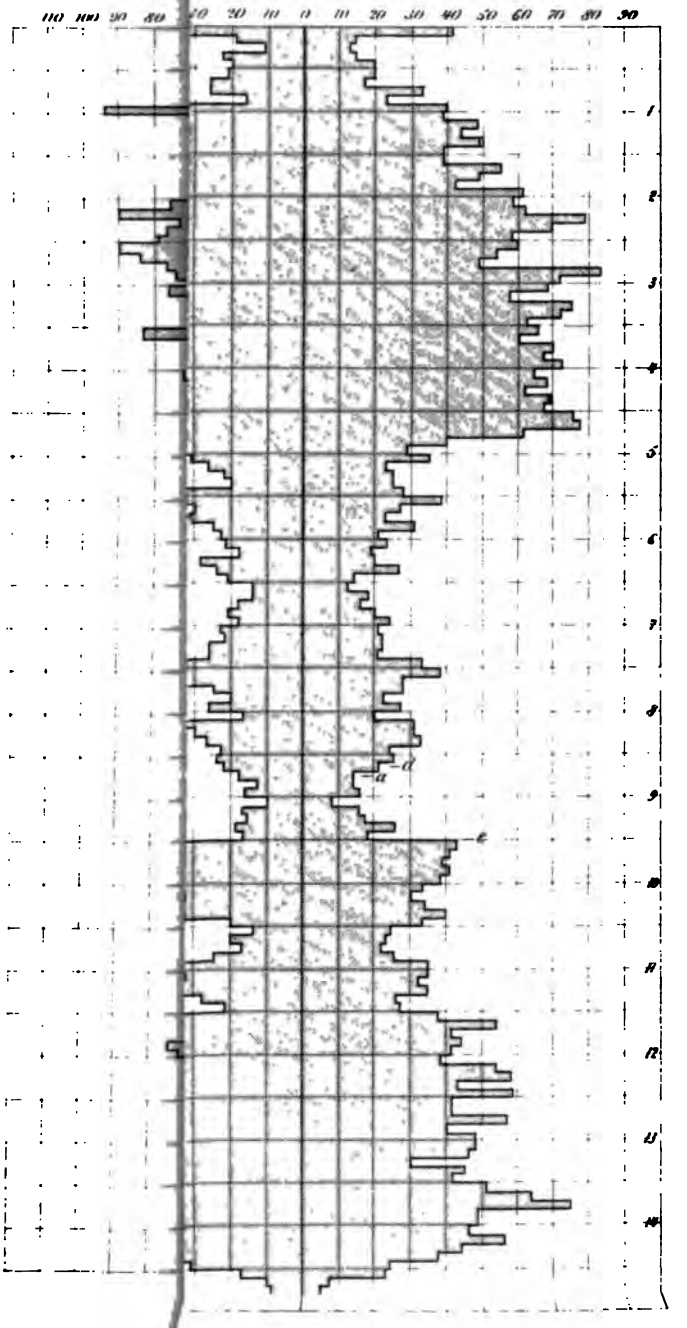


Fig. V

[illegible]ember of Cells in [illegible] m.



THIRTEENTH ANNUAL MEETING.

DECEMBER 26, 27 AND 28, 1882.

PROGRAMME.

TUESDAY, DEC. 26, 7:30 P. M.

Business Meeting — Reports of Officers.

WEDNESDAY, DEC. 27, 9:30 A. M.

Unfinished Business.

Paper: "Who built the Mounds."— Dr. P. R. HOY, Racine.

Paper: "Who made the Copper tools"— Dr. P. R. HOY, Racine.

Paper: "Greek Religion."— Prof. J. EMERSON, Beloit.

AFTERNOON SESSION, 2:30 P. M.

Paper: "Portraits of Columbus."— J. D. BUTLER, L.L. D., Madison.

Paper: "List of Fungi collected in Wisconsin." — WM. TRELEASE, Madison.

Paper: "Insanity."— A. O. WRIGHT, A. M., Madison.

Paper: "Our knowledge of Stellar Motion."— Prof. T. H. SAFFORD, Williamstown, Mass.

EVENING SESSION, 7:30 P. M.

Paper: (Institute of Christian Philosophy.) "The Unity of Moral Ideas." Rev. C. CAVERNO. Lombard, Ills.

THURSDAY, DEC. 28th, 9:30 A. M.

Paper: "The effect of local attractions on the Plumb line and Sea level." — Prof. J. E. DAVIES, Madison.

Paper: "Nature and Freedom."— Prof. J. J. ELMENDORF, Racine.

Paper: "Sorghum Sugar."— M. SWENSON, M. S., Madison.

AFTERNOON SESSION, 2:30 P. M.

Paper: (Institute of Christian Philosophy.) "The Ideal Man."— Prof. J. J. ELMENDORF, Racine.

Paper; "The Sochemanni."— PROF. W. F. ALLEN, Madison.

EVENING SESSION, 7:30 P. M.

Unfinished Business.

Paper: (Institute of Christian Philosophy.) "The Universality of Law."— Pres. JOHN BASCOM, Madison.

WHO BUILT THE MOUNDS?

By Dr. P. R. Hoy, Racine.

This question is often asked and variously answered. I purpose to treat the subject with due candor, offering such evidence only, as I consider authentic. Let us have the truth, though it should undermine the fanciful poetic fictions that have, from time to time, been advanced as the true solution of this mooted question. We read in papers and books on this subject, that the great antiquity of works is proven by the trees on or near them that a mound or fortification must be of great age for the trees were from three to four feet in diameter, or the very indefinite expression, there were *large trees* growing in such and such a locality.

Aside from the love of exaggeration, I am persuaded that there is a large margin for error in counting three or four inches of the outer margin of trees and thereupon estimating the age by multiplying the semi-diameter by this partial count.

The giant trees of California have been over and over again declared to be from three to four thousand years of age. In 1875, J. G. Lemmons was sent to ascertain the exact truth and report at the Centennial. On repeatedly counting the rings of at least a dozen trees, he found that their ages were from 1,000 to 1,500 years.

The celebrated tree, the stump of which is used as a floor for a ball room, is just 1,260 years old. Lemmons, during these investigations ascertained that by counting the rings on the outer foot and then, by this, estimating the age, the years would be doubled, for the growths varied from one-third of an inch in the interior, to the thickness of paper on the outside. So after repeated trials, he found that by counting a section one-third of the distance from the inside of the bark toward the centre, the age thus ascertained would correspond with the entire count. This rule was of great value to him in ascertaining the ages of the old prostrate trees. (Botanical Gazette, Vol. 3, Nos. 10 and 11.)

I have measured and counted the rings of many trees and find that in most forest trees Lemmons' rule is equally applicable.

Observation proves that forest trees acquire considerable size in comparatively few years. It is a rule in forestry to cut off the timber in 100 years from the planting, as it is then sufficiently large for all purposes, and after the expiration of one century the waste, decay, etc., equals the increase by growth. The fine shade trees that line our streets in Racine, more especially in the Second ward, are a source of pride and comfort to the citizens. I was one of the earliest settlers in this ward. In 1846–7 an organization for the purpose, planted trees some of which, by this time, have attained somewhat remarkable size. I have recently measured some of the largest. The white elms, *Ulmus Americana*, are from six to eight feet in circumference two feet from the ground. Maples from four to five feet; black and golden willows, eight feet; poplars, *Populus Candicans* eight and a half to nine feet. Not long since I had an opportunity of counting the rings and accurately measuring one of these street elms, finding the diameter two feet from the ground, inside of the bark, twenty-four inches, rings forty-eight,—an average of just one-fourth of an inch to a ring, giving an increase in diameter each year of one-half an inch.

Benjamin Bones, living four miles from Racine, cut down in 1870, a large white elm and on splitting it discovered, four inches from the centre, a blaze which included a hack evidently made by a sharp ax. He brought me a section of the tree including the blaze. There were one hundred and eighty-eight rings outside of the hack, measuring twenty-two and a half inches from inside of the bark to the blaze. Counting back and adding two years for the growths to cover the scar, we found that the period corresponded with Hennepin's first voyage along the west coast of Lake Michigan. A few years before this discovery Dr. Lapham and I amused ourselves tracing Father Hennepin's voyage. We located the spot where he halted and spent several days to recuperate. He says: "At this station the natives and voigeures we had with us killed plenty of stags, wild

goats and many turkeys, big and fat." The point where we located this halt is not over one-half a mile from this famous historic tree, which was fully four feet in diameter. It is probable that 203 years ago some of Hennepin's party blazed an elm sapling as a guide, and now the marks of that hatchet are revealed as sharp and distinct as when first made.

At the time Dr. Lapham and I surveyed the large group of mounds, near Racine, in September, 1850, there was a pin oak sapling growing on the centre of a small mound situated near the house of William Bull. That sapling is now fifty-six inches in diameter although that species of tree is ordinarily not a rapid grower.

Trees that are planted on the mounds, in Mound Cemetery have made a rapid growth being much larger than those planted at the same time in the adjacent grounds.

It has been asserted over and over again, without fear of contradiction, that the "Mound builders were an agricultural people and the Indians not." The truth is that the Indians well deserved the name agricultural.

When white men came to America they found corn in cultivation from latitude forty degrees south, to the St. Lawrence river of the north. Corn must have originated in a warm country, probably in Mexico. How it could have been adapted to the short summers of the regions so far north, is a matter of interesting inquiry. Without other agricultural education than that derived from their own unrecorded and necessarily imperfect observations, the Indians pushed the production of corn from the Gulf of Mexico to the St. Lawrence, Canada, ages before the white man visited them, and it was to the natives that the early settlers were indebted, not only for the seed corn, but for instruction as to planting and cultivation. An annual like corn may extend itself east or west along the same isothermal line by accidental causes, but it could not have moved into a much colder climate without skillful cultivation and careful attention to the selection and improvement of variety. It must have required ages to change it to such a degree as to fit it to grow and ripen in Canada.

When the Pilgrims first came among the Indians they bought great stores of venison and eight hogsheads of corn and beans. (Mourt's Relations. Drake, p. 79.) King Philip, *Metacomet,* was surprised and driven from his home on Mount Hope. The Pilgrims took "what he had worth taking, and spoiled the rest, and also took possession of one thousand acres of corn, which was harvested by the English and disposed of according to their directions." (Old Indian Chronicle. Drake, p. 209.) In the history of the Pequod war it is recorded that the Pequods had "two plantations three miles in sunder, and above 200 acres of corn, which the English destroyed." [Mourt's Relations. Drake, p. 116.) At Philip's Fort, in Rhode Island, there were 500 bushels of corn, stored in sections of hollow trees, each holding about one barrel. These "gums" were so placed as to afford a formidable breastwork. (Dr. I. Mather. Drake, p. 218.)

In the war between the Narragansets and the combined forces of the Mowhegans and Pequots, the latter "committed extensive robberies and destroyed twenty-three fields of corn." This occurred in 1637, so says Roger Williams. (Drake, p. 123.)

In Wisconsin, the Winnebagoes, Menomonies and Pottawatomies raised more corn than they required for their own use Clark says: "Gen Atkinson purchased, he thinks it was 6,000 bushels of corn of the Winnebagoes. In 1848, when my brother and I traveled extensively through Wisconsin, we drove in several instances over old Indian corn-fields, one of which in Columbia county, extended over half a mile. An old pioneer living near by told us the Winnebagoes had cultivaed this large corn-field. The Mandans and Riccarees of the west cultivate corn not only for their own use, but also enough to make it a prominent article of trade." (Antiquiites of Wisconsin, page 90.)

Gen. Wayne in his official report of a battle with the Indians of Northwestern Ohio in 1783, says: "A vast destruction of Indian property took place during the expedition. The very extensive and highly cultivated fields and gardens show the work of many hands. The margins of the beautiful rivers appeared like one continuous village for many

miles, nor have I ever before beheld such immense fields of corn. All were laid waste for twenty miles on each side of the rivers." In Western New York there were large fields of corn according to Champlain and Kirtland. In Eastern New York, Hudson mentions there being in several places extensive fields of corn. Marquis De Nouville in his celebrated expedition against the Seneca Indians says: "On the 14th of July, 1685, we marched to one of the large villages of Senecas where we encamped. We remained at the four Seneca villages for ten days. All the time we spent in destroying the corn which, including the old corn that was in *cache*, which we burned, was in such great abundance that the loss was computed at 400,000 minots or 1,200,000 bushels of Indian corn!" This was in Ontario county, New York. (Aboriginal Monuments in the State of New York, pp. 63 and 66.) Newport went up the Powhatan River to visit Powhatan in 1607. He states that Powhatan had extensive fields that came down to the river in which he cultivated corn, beans, peas, pumpkins, tobacco and flax. (Churchill and Holmes, Pickering p. 926.) De Soto speaks frequently of Indian villages that contained from 150 to 600 dwellings constructed of wood; sometimes walled in with stone and protected with tall palisades driven into the ground and surrounded by extensive fields of maize, beans, peas, pumpkins and other vegetables. In one instance he relates that his army passed through continuous fields of maize for two leagues—not a small field of corn even at the present time.

De Soto subsisted his army of one thousand men and two hundred and thirteen horses on the Indians' produce. At one place he took corn enough to feed his entire army for five days. He writes, "on Oct. 18 we came to Mobile, a walled city, which we captured and where we rested forty days. Found great stores of bear's fat, oil of walnuts and honey of bees stored in gourds. On March 3d, departed north with maize enough for sixty leagues."

De Soto's army wandered among and lived on the Indian four and a half years. It certainly took no small amount of corn and other provisions to subsist such an army for so long a period. The Seminoles, Cherokees, Chicasaws, Choc-

taws and Creeks were certainly a well-to-do people in an agricultural sense, at that early day, 350 years since, before the introduction of whiskey, which has well-nigh paralyzed their energies.

It is not uncommon for authors to assert confidently that the mounds were erected by a different race of people from the modern Indians, for the latter have no tradition of the mounds, by whom and for what purpose they were built. Let us consider the subject of *Indian Tradition.* Bartram, the zoologist and botanist, traveled in Georgia, Tennessee, Florida and South Carolina a little over one hundred years ago. He says: "At the Cherokee town of Cowe, on the Tennessee river, which contains one hundred houses, he noticed that the council house, a large rotunda, capable of accommodating several hundred people, stood on the top of an ancient artificial mound of earth, of about twenty feet in perpendicular elevation. The Cherokees themselves could give no account when or by whom the mound was built." At another important Cherokee town, Bartram saw a most remarkable column. It stood adjacent to the town, in the center of an oblique square, and was about forty feet high, and only from two to three feet thick at the base, and tapered gradually to a point at the top. What is remarkable about this pillar is, that notwithstanding it is formed of a single piece of pine timber, the Indians or white traders could give no account for what purpose or at what time it was erected. All the Indians that Bartram asked gave the same answer, which was that the ancient Indians found it there, and that their fathers knew nothing about it. This fact, says Bartram, is not singular, when reference is had to the mound of earth, but when the same answer is given concerning a perishable material, there is at least some slight ground for suspicion.

Another singular circumstance is that no pine trees grew nearer than twelve miles from this point. (Drake's Indians of North America, p. 63.)

None of the Indians at the present time have traditions running back as far as Allouez and Marquette, or even to the more recent time of John Carver. Is it not strange that

they have no knowledge of these men? The Winnebagoes and Menomonees assert positively that they never made flint arrowheads, stone axes or pottery, and that these things must have been made by some one else. White Snake, a chief of the Winnebagoes, said in all sincerity, they were never made by the Indians. (Antiquities of Wisconsin, p. 90, Smithsonian Report of 1879, p. 430.)

In view of these facts what weight has the lack of tradition respecting the mounds? Just none at all.

Jefferson, speaking of the barrows or mounds of Virginia, says: "But on whatsoever occasion they may have been made, they are of considerable notoriety among the Indians. About thirty years ago a party of Indians passing through that part of the country where a mound was situated, went through the woods directly to it, without instruction or inquiry, and staid about it for some time with expressions which were considered those of sorrow. They returned directly to the high road and pursued their journey after spending one half of a day in visiting the mound." (Drake's Indians, p. 56.)

Dr. Samuel Drake studied many of the mounds of Ohio. After describing stone axes, copper implements, flint arrowheads, teeth of carnivorous animals, mica and bone implements, shell beads, and various patterns of pottery, etc., he remarks, "this pottery was made of the same materials employed by the Louisiana Indians within my own recollection. namely, powdered muscle and other river shells, sand and clay."

Dr. Drake, in speaking of the rough stone walls found in several localities in Ohio, said that they were similar to those constructed by the Cherokee Indians of the south. (Drake's Indians, p. 57.)

Atwater, in 1819, surveyed and studied a large number of the ancient works of Ohio. He says: "What the true height of these ruined works was, cannot be very well ascertained, as it is almost impossible to know the rate of their diminution even were the space of time given. But there can be no doubt that most of them are much diminished by the action of the tempests which have swept over them for

ages. That they were the work of a different race from the present Indians, has been pretty confidently asserted; but, as yet, proof is entirely wanting to support such a conclusion. In a few instances European articles have been found in and about some of these works. But few persons of intelligence pronounced these works older than others of the same kind found occupied by the Indians at the time of the French wars." (Drake, p. 60).

Bartram in his travels in Florida relates: "The Indians collected the bones of the tribe and proceeded in a solemn manner to excavate a hole in the ground in which they deposited the bones, and after covering them up they elevated a *circular mound of earth over the spot.*" (Bartram's Travels, p. 514. New York Aboriginal Monuments, p. 68.) When Gen. Oglethrop landed in Georgia, in 1732, he communicated to the Indians the contents of the journal of Sir Walter Raleigh. They pointed out to Oglethrop a place near Yamacran bluff on which there was a large mound in which was buried, they said, a chief who had talked with Sir Walter Raleigh upon that spot. The chief had requested his people to bury him there. (Commissioners' Report on Georgia Affairs, p. 119. Drake's Indians, p. 369.)

A mound opened by Jefferson on the Ravenna river was attributed by him to recent Indians. (Jefferson's Notes on Virginia.)

A document accompanying the President's message of 1806 describes a mound of considerable size erected by the Natchez Indians when they were expelled from Louisiana (President Jefferson's Documents). Forbes was of the opinion that the mounds, thirty miles south of Natchez were erected by the Cherokee Indians. He states that the trees growing on the mounds were decidedly smaller than those growing on the adjacent grounds.

La Salle and his companions visited, two hundred years ago, the Natchez Indians. The town was surrounded by strong earthworks defended by tall stakes. They kept a perpetual fire burning on a mound which was forty-five feet high.

Bartram says in his Antiquities of Southern Indians that in his day the Choctaws erected mounds over the bones of the dead. The chief, *Tomachechi,* pointed out a large mound in which were the bones of a chief who had entertained a great white man with a red beard who came into the Savanna river in ships.

Walker describes many of the Florida mounds in the Smithsonian report of 1879. He excavated systematically a mound at the mouth of the Kootre river. A skull taken from the centre and base of the mound was broken in and inside of the head he found a *rusty iron spike* about three inches in length and a broken arrowhead. Excepting some highly ornamental fragments of pottery, these were all the relics he obtained in this mound. Walker also opened a mound on the south side of Alligator creek. This mound was circular in shape, forty-six feet in diameter, and about three feet in height.

He found many strings of colored glass beads, copper and brass ornaments. Among other curious objects was a pair of scissors and a fragment of a looking glass. By patience and care he obtained many strings of beads in the order they were worn by the owner. In two cases fragments of strings were preserved, seemingly by the copper. Many of the cut glass beads were very beautiful. Walker remarks that this mound could not be older than three hundred and forty years, probably much less. These trinkets may have been derived from De Soto, for tradition points out Phillips point, eight miles north of this mound as the spot where the Spaniards landed. (Smithsonian report 1879, p. 410.)

Dr. S. P. Hildreth opened a mound in Marietta, Ohio, and the circumstances were detailed by the accurate pen of the doctor. He relates: On removing the earth composing an ancient mound in a street of Marietta, the articles found were those belonging to the person over whom the mound was originally made. The articles were silver plated buckles and sword mountings; a streak of rust was all that remained of the blade. The name of Dr. Hildreth is sufficient guarantee that the statements are correct.

This mound must have been erected within a little over three hundred years at most. (Aboriginal Monuments of New York p. 187.)

Several silver crosses, a number of small bags of vermilion and other articles of European origin were discovered by C. A. Vaughn, of Cincinnati, in excavating several mounds in the vicinity of Beardstown, Ill. These articles were found within the skeleton at the base of the mounds. (Ancient Monuments of Mass., p. 146.) A small mound was opened near Chilicothe, Ohio, which was found to contain the skeleton of a girl enveloped in bark. (Ancient Mounds of Mississippi Valley, p. 171.)

In the year 1827, while constructing the Ohio canal a mound was removed under the supervision of William H. Price, at that time a member of board of Public Works. At the base of this mound with the skeleton, was a dial plate and other articles of European origin. (Ancient Mounds of Miss. Valley, p. 146.)

In Benton Township, Cuyahoga County, it became necessary to remove a small mound while excavating the Ohio canal. The remains of one or more human skeletons were found, also a gun barrel and some mountings of the stock. (Ancient Mounds of Miss. Valley, p. 146.)

In Green township, Chenango county, N. Y., there was a mound four feet high situated near Chenango creek, which was opened in 1829.

The mound had a pine stump standing on the top. Great numbers of human bones were found. These skeletons were lying without order, much decayed,and they crumbled on exposure. There were two heaps of flint arrowheads, one of which contained 200 of the usual pattern, color, black and yellow. At another point of the base of the mound, there were more than half as many of a smaller size. In the same mound a silver band or ring two inches in diameter, a number of stone gouges or chisels of different shapes and a piece of mica, heart-shaped and much decayed. (New York Aboriginal Monuments, p. 34.)

A remarkable work situated in Oneida county, N. Y., described by M. B. Clark, was inclosed with two rows of cedar

palisades, they being twelve feet apart and inclosing ten acres. When the ground was first plowed the burnt stumps of these palisades were turned up. In this fort there were six mounds, the largest of which was opened.

Near the base there was a layer of ashes beneath which were human bones, many trinkets made of red pipe stone (catlinite) and a great store of old iron articles consisting of axes, files, knives, etc. (N. Y. Aboriginal Monuments, p. 171.)

Lewis and Clark speaks of a mound in which a great chief of the Omahas had been interred. He was buried upon a hill and a mound six feet in height and twelve feet in diameter was erected over him. (Lewis and Clark Travels West of the Mississippi, New York Monuments, p. 107.)

Beck mentions a large mound on the Osage river which had been erected within the last thirty years by the Osages in honor of a dead chief. (Missouri Gazette, p. 308.)

James, in 1816, upon what he deemed good authority, gives an account of the discovery of a new-made mound which, when opened, disclosed the body of a white officer placed in a sitting position on a mat. (James' Expedition, Vol. 2, p. 38.)

Lapham discovered a mound situated in the town of Oak Creek, Milwaukee County, Wis.

This isolated mound was six feet in height. The sides were much steeper than any he had seen, which indicated that the mound was comparatively recent. Time sufficient to level down or spread out the mound had not elapsed. (Antiquities of Wisconsin, p. 10.)

The mounds near Lake Koshkonong, Jefferson county, Wisconsin, are of a recent construction, as proved by the bones being well preserved and containing considerable animal matter. The numerous bone implements and shell beads, wampun are alike well preserved.

I have studied carefully the large group of mounds situated near Racine, and have excavated fifty of the original one hundred and thirty-eight, which Dr. Lapham and I surveyed in 1850. These Racine mounds being of the oldest type, the bones are entirely destitute of animal matter. I asserted that the specimens exhibited at a meeting of the

Wisconsin Academy of Science, Arts and Letters from Koshkonong were of secondary interment, notwithstanding I was assured they were taken below the center of the mounds, under a stratum of cement, composed of burnt-fresh water shells. In order to prove or disprove Mr. Clark's investigation, a party of scientific men went from Milwaukee and opened one of these Koshkonong mounds. They ran a wide excavation through the center of the mound, starting two feet below the surface of the ground. They were rewarded and fully confirmed Clark's statement, and proved that these mounds are of no great age.

Dr. Sternberger, of the U. S. Army, critically examined certain mounds near Pensacola, Florida. These mounds proved to have been constructed by Indians, as blue glass beads were found in several of them.

Catlin observed a conical mound ten feet in height, erected over the body of a young chief of the Sioux tribe who had been accidentally killed on that spot. (N. A. Indians, vol. 2, p. 107.) James Mathew, a brother of Rev. Father Mathew, of Racine, settled on Zumbro River, in Olmstead county, Minnesota, in 1860. When he first plowed the land there was a mound six feet high and twenty feet in breadth, and so situated that it was in the way of properly cultivating the land, so he made the attempt to plow it down. He sank the plow to the beam repeatedly, but succeeded in reducing the height about two feet. The next year he procured a scraper, and went to work systematically to remove the entire mound. After scraping down the eminence to within about two feet of the base he came to some rotten wood. On carefully removing the top he discovered a kind of cage built of large stakes driven into the ground, as close together as possible, and covered with a split log, finished by plastering the outside thickly with clay, thus forming a rude lodge which was about three feet long and a little less in breadth. In this pen he found one skeleton of an adult in a good state of preservation and with the bones were found two iron hatchets, a dozen flint arrow heads, a copper ring two inches in diameter, a lot of shell beads and a red stone pipe of rather large size and ingeniously ornamented with lead.

Father Mathew visited his brother a few days after this find. On his return he brought the entire lot of implements with him.

George A West, an intelligent and thoroughly reliable gentleman, wrote me an accurate description of a mound opened, and of the interesting relics obtained. His letter is as follows:

RACINE, WISCONSIN, Jan. 15, 1881.

DR. HOY, SR.:

Dear Sir—Knowing that for years, the works of the mound-builders have been closely studied by you, allow me the pleasure of describing to you a few particulars in regard to a mound opened by me in the year 1870.

When an uncle of mine by the name of Davis, was trapping on Root river, in the town of Raymond, Racine Co., he discovered two small mounds on the northwest quarter of section 15. The mounds were situated on the east bank of the river, above highwater mark, yet very near to the stream, on a sand bank. One was partly eaten away by the stream, and the other, situated a few rods away, was covered with hazel brush, with a few large trees standing near by. The mounds were each about ten feet across and two and a half feet above the level of the surrounding ground.

We concluded to open the remaining mound; so after removing the hazel brush and digging about three feet through sand and roots, we came to a bed of hard blue clay, which we threw out in chunks; beneath the clay we came to a sort of a cavity containing fragments of bone and dark streaks of earth, which marked the location of what was at one time a human form.

From the appearance of what remained we concluded that the person must have been buried in a sitting posture; for we found a tooth or two where apparently the pelvis was located, which must have dropped from the jaw above. By exercising care we might have preserved a complete cast of the interred, in the hard clay surrounding him.

Near the center of the mound we found a copper kettle, with a hole in its bottom; within the kettle there was a quantity of dark earth, which was composed mostly of vegetable matter; being such a shapeless mass we were unable to determine just what it might have been. The kettle was about six inches across, with straight sides; it had ears and no bale, and in one place on its side where there had been a hole, there was a rivet inserted, made of copper. The kettle was badly rust-eaten, and when new must have been very thin; Mr. Davis either disposed of it or took it away with him, and where it is remains a mystery. We also found a copper spear head and two irregular pieces of copper. The spear head was about three inches long, with a rivet hole in the shank. The pieces of copper show marks of pounding; they contain particles of silver and quartz, which show that they were never smelted. I am in possession of

them. We, before restoring the mound, dug a foot or two in each direction, but found nothing more.

Very truly yours, GEO. H. WEST.

About fifteen years ago, John Elkins, a jeweler of Racine, told me that he had bought a lot of silver trinkets, ear-rings, belt-slides, and a fine double cross. These, he said, were found in a mound situated in a street in Burlington. Supposing these things to have been a secondary deposit, I made no especial inquiry at the time. However, when I received the report from Mr. West of the Raymond mounds, I determined to investigate the Burlington mounds. With this object in view I attended a meeting of the old settlers association, held in a grove near the village of Burlington, Racine Co., Wis. I called upon F. S. Perkins, who accompanied me to the grove to assist in finding the old Burlington pioneers. We found many who knew that a mound had been removed and that there were lots of silver trinkets and some brass kettles found, but they could give me no further information. They all, however, told me to write to Nathaniel Dickinson, of Elkhorn, Wis., and that I would get a prompt reply, and he would give me all the facts as accurately as if the event was of last week, being a man of extraordinary memory. I wrote to him, and on the third day received a reply as follows :

ELKHORN, WISCONSIN, June 26, 1881.

DR. P. R. HOY:

Dear Sir — There were originally three mounds situated near the junction of the White and Fox rivers. In seasons of freshets the locality of these mounds was covered with water. They occupied an irregular triangle, four to six rods apart.

The mounds in shape were each a section of a sphere. The two smaller ones were three feet in height and fifteen feet in diameter at the base. The remaining one was much larger, being six feet in elevation by twenty in diameter. They were composed of the surface sandy loam and apparently built without extended intermission of time.

In the fall of 1852, I was road commissioner and built a wooden bridge over White river, near where it joins the Fox. This bridge has since given place to one of iron. Requiring some earth for filling the approach I removed one of the small mounds that stood on the street.

When we came to the original surface, we found the shape of four persons, two adults and two children. Each was covered with a thick

stratum of compact clay thus forming a rude kind of sarcophagus. On breaking open these clay cases we found human bones partly decayed and three copper kettles, one of which had some nuts in it, perhaps Pecans; another had what are supposed to be the bones of a rabbit; also, there were many silver ear-rings breast pins and one beautiful double armed, ringed, silver cross, with R. C. in roman capitals engraved in the centre of the upper arm of the cross, also a large quantity of blue glass beads. The remaining small mound we opened out of curiosity. We sank a wide shaft over the centre; when we came to the original surface of the soil and found one clay covered skeleton in a fine state of preservation. There was one copper kettle of rather large size and a small fur-covered, brass-nailed trunk, ten by twelve inches, and eight inches in height. In this trunk we discovered a lot of cheap silver trinkets. In the kettle there was some brown substance which we could not determine and over this brown substance were two or three folds of a woolen blanket.

I might have said, in its proper place that the clay was obtained on the opposite shore of White river, the only locality where this kind of clay could be procured in this vicinity.

A Mr. Stowell built a house over the large mound and when they dug the cellar they removed a part of this mound but nothing was found; still it may be that the centre of the mound was not disturbed. Kettles, silver and crania were scattered, some by gift, others loaned without exacting a return, so that at this time I cannot direct you where you can obtain any of the relics.

Should you require further information in addition to the above commonplace recital you can make any inquiry that you may wish and I will answer.

Yours truly,

NATHANIEL DICKINSON.

In answer to further inquiry, I received the following:

The clay-covered skeletons were central, and on a level with the original undisturbed soil, the second mound opened we did not sink below the base of the mound, as it would be of no use, as we fully proved in the case of the one removed, that the soil below was not disturbed, and in the second opened, the water from White river was within two feet of its base, as this mound was at a lower level than the other two mounds.

These two Dickinson mounds, the West mound, on Raymond, and the Mathew mound, in Minnesota, were certainly not older than 300 years, and in all probability not over seventy-five years, judging from the fur-covered trunk and wooden cage.

Mounds are usually found in groups of from three to thirty. In these groups one is almost always much larger

than those placed irregularly about the patriarch of this mound family. In the large mounds it is not uncommon to find secondary burials, which are mostly near the surface. On the other hand, the small mounds are never interfered with, so far as I can ascertain from personal inspection and extensive ii quiry. Mounds are not usually opened with sufficient care. In most cases, when the report is that there was a confused heap of bones, critical investigation would prove that the skeletons were originally placed in a sitting position, and that the apparent confusion is caused by the skeletons falling over at various angles, the legs alone retaining their original position.

The Wisconsin mounds are all sepulchral, with the exception of the so-called *animal mounds.*

Squier, after a thorough investigation of the earthworks, mounds and fortifications of New York says:

"In full view of the facts before presented I am driven to the conclusion little anticipated when I started on my trip of exploration, that these earthworks were erected by Iroquois and Senecas or their western neighbors; that the tribes that inhabited New York were to a degree fixed and agricultural in habit." (Aboriginal Monuments of New York, p. 83.)

Further on he says the light thrown upon the Ohio works by those situated in western New York has led to an entire modification of his former views regarding the Ohio works, and to the conviction that they are all of a comparatively late date and probably of common origin.

The flint arrow and spear points, the stone axes, pipes and ornaments, as well as various forms of pottery, are identical in shape, material and workmanship with those known to be used and manufactured by the Indians, when the Europeans first came among them. No one can tell by inspecting these articles whether they were taken from a mound or picked up on the site of a known Indian village. Shell beads found so commonly in mounds and Indian graves were their money — wampum — just such as the Indians living along the New England coast used to make continually. They gathered great quantities of small univalve sea shells

in summer that they could continue the money making during the winter. They managed to bore a hole in these shells with a flint, before the whites furnished them with awls and drills. (Drake's Indians, page 229; Pickering's Chronological History, page 955.)

The various species of large univalve shells, "conchs," so often found in mounds and Indian graves, are yet preserved in the Omaha wigwams as sacred. The sound heard when one of these shells is placed to the ear is supposed to be the voice of departed spirits. (Paper read by Miss Fletcher at Montreal meeting of A. A. A. S.)

Then the mode of burial is still the same, mostly in a sitting posture, surrounded by their worldly wealth and supplied with a sufficiency of food to feed the hungry soul while on the long road to the happy hunting ground. I should like to see that anatomist who can distinguish the crania taken from mounds from those procured from Indian graves. The skulls from mounds differ just as much and just as little as do those of the present tribes of Indians. I obtained a skull of a Pottawatomie chief (it is now in the U. S. A. medical museum at Washington), which is one of the largest known. It is very symmetrical also, the capacity being 1785 cubic centimeters; maximum length, 188.9; maximum breadth, 163.5. circumference, 555.6; facial angle, 75; measured and photographed by order of the surgeon general. I had a second Pottawatomie cranium that is as unlike the above as possible, the capacity being 40 cubic inches less, facial angle 70. In view of the foregoing evidence, the legitimate conclusion must follow that the "mound builders" were Indians and nothing but Indians, the immediate ancestors of the present tribes as well as many other Indians that formerly were scattered over this country. Differing in habits of life and language just as the Indians of the several tribes did before the white man changed them, they continued to build mounds after they had communication with Europeans, since which time mound building, together with many of the arts of the red man, such as making wampum, flint, stone and copper implements, pottery, etc., have declined and finally nearly or quite ceased.

WHO MADE THE ANCIENT COPPER IMPLEMENTS.

By Dr. P. R. Hoy, Racine.

Elsewhere I have considered how the ancient copper implements were fabricated. This paper will be devoted to the answer of the question who made the ancient copper implements, that the plow and spade reveal so abundantly over Wisconsin and sparingly over most of the other states and Canada.

The early explorers upon the St. Lawrence in Canada, on the coast of New England, New York, Virginia, the Carolinas and Florida (among whom we will mention Cartier, Alfonse, Varanzano, Raleigh, Heriot, Ribauld, Newport, Allouez, Champlain and De Soto), all concur in saying that the Indians had implements and ornaments made of copper. Alexander Henry, who penetrated to Lake Superior at the time of the French war, assures us that the Indians obtained copper here which they made into bracelets, beads, spoons and other articles. (Henry's Travels p. 195.)

Dr. Jackson, of Boston, who spent several years on Lake Superior during the early period of the copper excitement, told me (in the summer of 1844, which I spent in the copper region) that "it was undoubtedly the Chippewas that mined, and probably the French half-breeds assisted in these old mines. The fresh condition of the wood work, skids and ladders, and the evidence that sharp axes were used in fitting the timbers is evidence that they are not of great antiquity." Dr. Jackson has published since similar views regarding these old mines.

Charles Whittlesey, U. S. Geologist, in the course of the geological survey of the Lake Superior district, writes: "In the old works on the Minnesota location near the forks of the Ontonogan river there was found at the depth of eighteen feet, a mass of copper weighing eleven thousand five hundred and eighty-eight pounds, which had been taken out of the vein by the ancients. It had been raised a few feet along the slope of the vein by means of wedges and cob-work made of

logs laid up in the form of the body of a small log house. I had a piece of one of these logs which was cut from a black oak tree about six inches in diameter, showing distinctly the marks of a narrow axe, one and three-quarter inches wide, and *very sharp*. The marks of the instrument by which it was cut off were as plain and as perfect as they were on the log and stump recently cut in the vicinity.

Directly over the mass and over the timber which supported it, there stood on the rubbish which covered the mass about twelve feet in depth, a hemlock tree that had two hundred and eighty rings. There was a part of a wooden bowl and a wooden paddle taken from this old mine.

There were a number of wooden paddles found by Doctor Blake, in an old mine, at the Copper Falls mine, all of which were made of white cedar, which is abundant on Lake Superior. Most of these paddles were six feet in length, and resembled those used by the Chippewas in size, shape and material. The handles of these paddles used in the old mines were shaved with a knife or some other sharp cutting tool. In these old mines (Copper Falls), there was a skid with marks showing that it was cut with a sharp ax. There was also a bark spout for conveying the water from the locality. There was a birch tree growing over this debris which was two feet in diameter. The only implements found there which are made of copper, found in the rubbish of the old works, at a depth of from five to fifteen feet below the present surface, were one chisel, five inches long and an inch wide, a gad or wedge and one spear head of the ordinary pattern, four and one-half inches in length, with a socket for a handle." (Annals of Science, edited by Hamilton L. Smith, pages 28–30.)

It was reported by Singaba W'orsa (the head Chippewa chief), that when the Chippewas assembled at their councils from many points of the Lake Superior region, they had abundance of copper which led the council to the conclusion that copper abounded in many locations. In 1826, this intelligent chief piloted the U. S. Indian Commissioner, Gen. McKenny and party, to a celebrated mass of copper which had been long known by the Chippewas.

The commissioners went prepared to remove the mass, with a view of sending it to Washington. "We found it thirty-five miles above the mouth of the Ontanogan river, Lake Superior, on the west bank of the river, a few paces above low water mark. It consisted of pure copper, ramified in every direction through by a mass of stone (mostly serpentine, with calcareous spar), in veins of from one to three inches in diameter, and in some parts exhibiting masses of pure copper of over one hundred pounds. The entire weight of the mass was estimated at from three to five thousand pounds. It was found impossible, owing to the channel of the river being intercepted by ridges of sandstone, forming three cataracts with a descent in all of about seventy feet, to remove this great national curiosity. Evidence was discovered in prying the rock of copper from its position, confirming the history of the past, which recorded the efforts of other parties to extract wealth from this mass. These evidences consisted in chisels, axes and various implements, which are used in mining. This copper mass must have been much larger in dimensions, as no doubt those formerly working it removed much of the copper." (History of Indian Tribes of North America, by Gen. McKinney, Vol. I, p. 159.) This minute account is proof positive that long before 1826 persons operated on this mass of copper with sharp tools.

An extensive find of copper implements near the Sault Ste. Marie has recently been made. It contained twenty-three pieces, consisting of six awls, the largest six inches in length, the smallest three inches, five knives of various sizes and thirteen pieces composed of axes, hammers and chisels. They were found lying piled compactly together, surmounted by a little pile of stones. (*American Antiquarian* Vol. 5, No. 1, p. 89.)

The French penetrated to the Lake Superior region about three hundred and fifty years since — a time quite sufficient to account for all the old mining operations yet discovered.

Newport was told by Powhatan with whom he banqueted April, 1607, that the copper they had "was got in the bites of rocks between cliffs in certain veins a great distance north." (Dr. Pickering's Chronological History, p. 926.)

Granville speaks of copper among the Indians of Virginia which was said to have been obtained of the Shawnees. It was of the color of our copper, but much softer. (Granville's voyages in 1685. Vol. 12, p. 580.)

William N. Rogers, for several years connected with the Indian agency at Keshena, Wisconsin, told me that he frequently saw copper implements in the hands of the Chippeways and Winnebagoes. Many of their pipes were ornamented with copper.

One celebrated calumet which formerly belonged to Black Hawk, now owned by a Winnebago chief, has a broad rim of copper with great blotches of native silver.

The following is a copy of a letter of the Hon. Saterlee Clark, former Indian agent for the Winnebagoes from 1828 to 1830:

HORICON, WIS., May 9th, 1881.

DR. P. R. HOY:

My Dear Sir—In answer to your communication, Feb., 27th, * * *

When I first came among the Winnebagoes many of them had copper-headed weapons.

Many of them carried lances headed with copper, and it was quite common to see arrows headed with copper. Masses of virgin copper both large and small were often found scattered about, but particularly in the sand on the beach of the Wisconsin. This was so pure and soft that it was no trouble to shape it to suit them.

I have never seen any native copper vessels among them of any description, of their own manufacture. Very respectfully,

[Signed.] SAT. CLARK.

The original is in my possession.

I have a perfect copper implement eight inches in length, tapering to a fine point at one end and to a blunt point at the other, form square, each side at the center three-eighths of an inch wide. It was ploughed up with a few Indian bones by William Hass in the town of Caledonia. This grave was situated on a high bank overlooking the Root river. I inspected the grave.

John Trasen, living near the river, told me that there were Indian bones sticking out of the river bank. On visiting the spot we found three graves partially uncovered by the washing away of the bank. Two of the skeletons were

f adults and the third proved to be that of a child. The dult graves were situated ten feet apart and sixteen inches elow the surface from above.

On carefully digging we found in each several copper imlements, nearly all of which were badly oxidized, while some rticles had nearly disappeared. There was a succession of mall rounded articles which we took to be copper beads. here were several small cylindrical articles of copper which ere three to four inches in length.

In each of these three graves were remnants of pottery. n one of these pots there was a yellow paint that I could ot determine. In the second adult grave was a red paint hat proved to be vermilion. In connection with the child's rave I found two blue cut glass beads. The balance no loubt were appropriated by the river. In each adult grave here were the leg bones of a deer. The dead were supplied vith venison while they lingered on the road to the blessed unting grounds. A copper lance head was found by George Vest in Raymond, the description of which is given in West's etter in "On the Mounds."

There were also two pieces of copper, one of which had ever been float-copper, but had been mined, as all the deep ngles and ridges were sharp and not in the least rounded. he other specimen had been pounded out and a portion ut off had specks of silver associated with the copper.

Prof. Butler exhibited to me a spear head which had been lowed up by Sanford Marsh, in Waukesha county. The hole vas filled with what appeared to be iron rust; on scraping e found a small fragment of the rivet. On applying the nagnet it proved to be iron.

There can be no doubt that this spear head was manuactured after the Indians traded with the whites. (Since his was written Prof. Butler has published a description of his article in the *American Antiquarian.*)

F. S. Perkins, of Burlington, has collected nearly 400 copper implements, not counting beads, and not one single specinen was taken from a mound. Nearly all were plowed up r picked up from the surface. Mr. Perkins sold his origial collection, consisting of 143 copper implements, to the

Wisconsin Historical Society, and has since devoted much energy to the collecting of a second cabinet of copper. He has now about two hundred specimens, many of which are unsurpassed. There are eight axes ranging from two to five pounds in weight. The largest implement weighs ten pounds two ounces. Among this magnificent collection he has ninety spear heads alone.

Near Racine there has been at least one hundred mounds either opened or entirely removed concerning fifty of which I have personal knowledge, and not one single specimen of copper has been discovered in these mounds and as this group is of the oldest type, and as they are situated in the region of abundance of copper, the fact leads to the inference that they were built before copper became of common use among the Indians. This is the more likely as the later mounds have not infrequently articles manufactured from nativecopper. The conclusion follows that the Indians living at no great distance from the copper regions of Lake Superior did mine copper and make various ornaments and implements, not only for their own use, but extensively for the purpose of barter with distant tribes and nations of Indians.

PRELIMINARY LIST OF WISCONSIN PARASITIC FUNGI.

By WILLIAM TRELEASE, S. D., Professor of Botany, University of Wisconsin.

The following provisional list of the parasitic fungi of the state includes only species which have been examined by myself. With one or two exceptions, specimens of all have been preserved in my herbarium.[1] Most of the species were collected about Madison, by myself; although I have received much valuable assistance from Mr. L. H. Pammel, a special student in my laboratory, and a most excellent collector.

[1] Dr. Bundy informs me that none of the fungi enumerated in his list in the first volume of the Report on the Geological Survey were saved, so that I have been unable to refer to them.

who has also contributed many interesting forms from La Crosse and elsewhere. A few species have been received from correspondents, whose contributions are acknowledged in each instance.

Professor W. G. Farlow, of Harvard University, has aided me very materially in the determination of doubtful species. My thanks are also due Dr. M. C. Cooke, Prof. C. H. Peck and Mr. J. B. Ellis for similar assistance.

Where names different from those in common use have been employed, in deference to European authority, the synonym most frequently used is added in parenthesis.

As the list now stands it includes about 270 species on approximately the same number of hosts, most of which are phaenogamic plants. This number will probably be nearly doubled by a few years' collecting, especially through the addition of imperfect forms belonging to *Cercospora*, *Septoria*, and related form-genera. To this end, I shall be grateful for specimens from any part of the state, and will gladly render any assistance in my power in their identification.

CHYTRIDINEAE.

1. SYNCHYTRIUM FULGENS Schroeter, var. DECIPIENS Farlow.
   Very common, on *Amphicarpaea monoica* Nutt. Madison, Ithaca; La Crosse, Pammel.

2. SYNCHYTRIUM ANEMONES (D C.).
   Common, on *Anemone nemorosa* L. Madison.

SAPROLEGNIEAE.

3. SAPROLEGNIA FERAX (Gruithus), form THURETII De Bary. (*S. dioica* Auct.).
   On dead flies thrown in water. Madison.

This species has not been found occurring parasitically with us, but it is frequently known to attack living aquatic animals, especially fish, and is the chief cause of the destructive salmon disease of England. It was obtained on some cultures started with cistern water in the spring of 1882, and again, in the fall of 1883, in water taken from a ditch. Antheridia have not been observed. A small percentage of the oogonia show a pseudo-pollinodium projecting into the base of the cell from below.

PERONOSPOREAE.

4. CYSTOPUS CANDIDUS (P.).

Common, through the open season, on various crucifers,—*Capella bursa pastoris* Moench, *Sisymbrium officinale* Scop., etc. Madison, Syene; Kirkland, La Crosse, Pammel.

5. CYSTOPUS CUBICUS (Strauss).

On *Ambrosia artemisiaefolia* L., *Cnicus lanceolatus* Hoffm. and *Artemisia biennis* Willd. Madison; La Crosse, Pammel.

6. CYSTOPUS BLITI Biv. (*C. amaranthi*, S.).

On *Amarantus retroflexus* L. Syene, Madison; La Crosse, Pammel.

7. CYSTOPUS PORTULACAE (D C.).

On *Portulaca oleracea* L. Madison; La Crosse, Pammel; Sauk City, Lüders.

8. PHYTOPHTHORA INFESTANS (Mont.) (*Peronospora infestans*, Mont.).

Common, in wet summers, on *Solanum tuberosum* L. Madison; and received from many parts of the state.

In some years the loss from the potato rot is estimated at many thousands of dollars in Wisconsin.

9. PERONOSPORA VITICOLA (B. & C.).

On various cultivated and wild grapes, and on *Ampelopsis quinquefolia* Michx. Madison, Syene, Ithaca; La Crosse, Devil's Lake, Pammel; also reported from every part of the state.

This certainly causes very much of the dry rot of grapes, as pointed out by Prillieux (Comptes Rendus, Oct. 2, 1882), who has more recently succeeded in observing the germination of the oospores by the direct emission of a mycelial thread, without the intervention of zoospores. I have collected it once producing conidiophores on the fruit.

10. PERONOSPORA HALSTEDII Farlow.

On *Bidens frondosa* L., *Ambrosia artemisiaefolia* L., *A. trifida* L., *Eupatorium ageratoides* L., *Rudbeckia laciniata* L., *Silphium terebinthinaceum* L., *S. integrifolium* Mx., *S. trifoliatum* L., *S. perfoliatum* L., *Helianthus strumosus* L., *H. occidentalis* Ridd., *H. tuberosus* L. and *Solidago riddellii* Frank. Madison; La Crosse, Pammel.

11. PERONOSPORA OBDUCENS Schr.

On cotyledons and young leaves of *Impatiens fulva* Nutt. Madison; La Crosse, Pammel. Also found on *Impatiens pallida* Nutt., at Hokah, Minn., by Mr. Pammel.

12. PERONOSPORA GERANII Peck.
On *Geranium maculatum* L. Madison, Stoughton; Kirkland, Pammel.

13. PERONOSPORA ENTOSPORA (Roze & Cornu) (*P. simplex* Peck).
On *Aster novae angliae* L. and several unidentified species of *Solidago*. Syene; Stoughton; La Crosse, Pammel.

14. PERONOSPORA PYGMAEA Unger.
On leaves of *Anemone nemorosa* L., in May. Madison.

15. PERONOSPORA GANGLIFORMIS (Berk.).
On *Lactuca sativa* L. and *L. canadensis* L. Madison and Syene; La Crosse, Pammel.

16. PERONOSPORA PARASITICA (Pers.).
Common, on *Capsella bursa pastoris* Moench, *Lepidium virginicum* L., *Nasturtium armoracia* Fr. and *Brassica* sp. Madison, Syene; Baraboo, La Crosse, Pammel.

17. PERONOSPORA POTENTILLAE De Bary.
On *Potentilla norvegica* L. Madison; La Crosse, Pammel.

18. PERONOSPORA ARTHURI Farlow.
On *Oenothera biennis* L. Stoughton; La Crosse, Pammel.

19. PERONOSPORA VICIAE (Berk.).
On *Vicia faba* L. and *V. americana* Muhl. La Crosse, Baraboo, Pammel.

20. PERONOSPORA EFFUSA (Grev.).
Common on *Chenopodium album* L., in summer. Madison; La Crosse, Baraboo, Pammel.

21. PERONOSPORA ALTA Fckl.
On *Plantago major* L. Madison; La Crosse, Pammel.

22. PERONOSPORA CALOTHECA DeBary.
On *Galium boreale* L. and *G. triflorum* Michx. La Crosse, Pammel.

23. PERONOSPORA URTICAE (Lib.).
On *Urtica gracilis* Ait. Kirkland, La Crosse, Pammel.

24. PERONOSPORA CORYDALIS DeBary.
On leaves of *Dicentra cucullaria* D C. Madison.
Locally abundant, covering the entire lower surface of the leaf with a matted, gray felt.

24*a*. PERONOSPORA LEPTOSPERMA DeBary.
On *Artemisia* sp. La Crosse, Pammel.

25. PERONOSPORA AUSTRALIS Spegaz. (*P. sicyicola* Trelease, *Botrytis cubensis* B. & C.?).

Very abundant in summer and fall, on *Sicyos angulatus* L. Madison, Stoughton.

This species was first found in the summer of 1882. Its presence is indicated by pale spots on the upper surface of the leaf, opposite which the fruiting hyphae emerge in dense white tufts 1-3 mm. in diameter, with angular contour, limited by the veinlets of the leaf. Later these spots become dead and white, resembling those caused by *Ramularia*, *Septoria*, etc.

Berkeley and Curtis describe a *Peronospora cubensis* on a West Indian cucurbitaceous plant (Journ. Linn. Soc., Bot., X., 368), but their description, like many of Berkeley's, is unsatisfactory and does not well apply to our plant. Through the courtesy of Dr. Farlow, I have made a thorough examination of the leaf said to bear *Botrytis cubensis*, in the Curtis herbarium, but whatever it may have once contained has entirely disappeared: and a careful search on the Wright duplicates at Cambridge, which Dr. Farlow was kind enough to make, does not show any *Peronospora*. The species was, therefore, named *P. sicyicola* in my herbarium and in this paper as first presented, and a description was given by Dr. Farlow, in the Botanical Gazette for 1883, p. 331. Since that was published the description of a South American species on *Cyclanthera*, discovered by Spegazzini, has reached this country. So far as can be made out, this is identical with the Wisconsin form, and the name of Spegazzini has the right of priority, dating from 1881. His description is as follows: "Hypophylla: maculae amphigenae, magnitudine ludentes, primo parvulae, dein saepe totum folium occupantes, pallescentes v. fusco-pellucidescentes, angulosae: hyphae mycelii crassae, subtorulosae: haustoria subsphaeroidea v. subclavata, numerosa, saepe totam cellulam plantae hospitalis implectantia: hyphae fertiles hinc inde erumpentes v. e stomatibus exsurgentes, rectae-cylindraceae, longiusculae (250—500 × 14—15 μ), hinc inde glomerulatae, usque ad verticem continuae, inferne saepe incrassatulae, sed mox breviter ac abrupte coarctato-attenuate, apice subverticillatim 5—12 ramosae: rami 3—6-ies trichotomi, gradatim alternati, ac abbreviati: ramuli ultimi apice incrassatuli, 3—5 sterigmata (3.5×1.5—2 μ) hyalina, subampulliformia, inter se angulo-recto divergentia, saepe 2-3 denticulato-lobata gerentia; conidia obovato-sphaeroidea, sursum obtuse rotundata, saepeque apiculata (15×10—12μ), hyalina."—Ann. de la Sociedad Cientif. Argentina, 1881, XII., p. 81.

In our form the conidial branches are hyaline, tufted from the stomata, often .5 mm. high, with a diameter of 12 μ. 3-4 times branched below. Primary branches alternate, ascending. Ultimate and often penultimate twigs spreading, the lateral ones in pairs, forming crosses with the branch which bears them. Conidia hyaline, subspherical or broadly ellipsoidal, variable in size, averaging 13×16 μ; with an apical papilla, hence probably germinating by zoospores. Oospores not seen.

26. PERONOSPORA LOPHANTHI Farlow.
On *Lophanthus scrophulariaefolius* Benth. La Crosse, Pammel.

27. PERONOSPORA SCHLEIDENIANA DeBary.
On leaves of *Allium cepa* L.
Called "onion-rust," and very destructive.

28. PERONOSPORA GRAMINICOLA (Sacc.) (*Protomyces graminicola* Sacc., *Peronospora setariae* Pass.).
On leaves of *Setaria viridis* Beauv. and *S. italica* Kunth. La Crosse, and Hokah, Minn., Pammel.
The oospores give some leaves a decided brown color. Conidial branches sparingly produced.

ASCOMYCETES.

GYMNOASCI.

29. EXOASCUS PRUNI Fckl.
On the fruit of *Prunus*, causing "plum pockets" or "bladder plums." Stoughton; Ahnapee, Swaty; Ithaca, Hatch.

30. ASCOMYCES COERULESCENS Mont.
On leaves of *Quercus coccinea* Wang. and *Q. rubra* L. Stoughton; Kirkland, La Crosse, Pammel.

PERISPORIACEAE.

31. UNCINULA ADUNCA (Wall.) (*U. heliciformis* Howe).
Common, in fall, on species of *Salix*, and on *Populus balsamifera* L., var. *candicans* Gray.

32. UNCINULA SUBFUSCA B. & C. (*U. ampelopsidis* Peck).
On *Ampelopsis quinquefolia* Mich. Madison; LaCrosse, Pammel.
This is given the name of Berkeley and Curtis on the authority of Cooke —Journ. Roy. Hort. Soc., 1878, p. 72.

33. UNCINULA AMERICANA Howe (*U. spiralis* B. & C.).
On leaves of cultivated grape, in the fall. Syene.

34. UNCINULA CIRCINATA C. & P.
On leaves of *Acer rubrum* L. Ithaca.

35. MICROSPHAERA EUPHORBIAE B. & C.
On *Euphorbia corollata* L. Madison; La Crosse, Pammel.

36. MICROSPHAERA FRIESII Lév.
On *Syringa vulgaris* L., very common, disfiguring the lilacs in summer and fall. Madison.

37. MICROSPHAERA DIFFUSA C. & P.

On *Desmodium canescens* D C, *Lathyrus ochroleucus* Hook. and *Lespedeza violacea* Pers. Madison; Delton, Devil's Lake. La-Crosse, Pammel.

The form on *Lathyrus* has the 8–12 hyaline appendagas 4–5 times forked, the ultimate divisions unequal, some of them straight, others recurved, closely resembling those of *M. ravenelii* B., which occurs on *Gleditschia*. They are also absolutely indistinguishable from those of *M. pulchra* C. & P., in my collection. Mr. Ellis writes, however, that this form does not differ more from Peck's specimens of *M. diffusa* than the latter do from those of Ravenel distributed by Cooke in Ravenel's Fung. Amer.; in the latter of which they are merely dichotomous and spreading as in my specimens on *Desmodium*, whereas in the former they are only a little less ornate than in my specimen on *Lathyrus*. Professor Peck also regards this as a form of his species.

38. MICROSPHAERA PULCHRA C. & P.

On *Lonicera flava* Sims. and *L. parviflora* Lam. Madison; La-Crosse, Pammel.

39. MICROSPHAERA VAN BRUNTIANA Gerard.

On *Sambucus canadensis* L. Madison.

40. MICROSPHAERA PENICILLATA (Wall.).

On *Corylus americana* Walt. and *C. rostrata* Ait. Very common in the fall. Madison.

41. MICROSPHAERA EXTENSA C. & P.

On leave of *Quercus rubra* L. Madison.

42. MICROSPHAERA RUSSELII Clinton.

On *Oxalis stricta* L. La Crosse, Pammel.

43. PODOSPHAERA TRIDACTYLA (Wall.) (*P. kunzei* Lév., *P. oxyacanthae*, D C.).

Common, on leaves of cultivated cherry and plum, and on *Prunus virginiana* L., causing the leaves to fold lengthwise. Madison, Ithaca; La Crosse, Pammel.

44. PHYLLACTINIA SUFFULTA (Reb.) (*P. guttata*, Wall.).

On *Celastrus scandens* L., *Carpinus americana* Michx., *Corylus americana* Walt. and species of *Cornus* and *Fraxinus*. Madison.

45. SPHAEROTHECA CASTAGNEI Lév.

Common, on *Bidens frondosa* L., *Nabalus* sp., *Taraxacum dens-leonis* Desf., *Veronica virginica* L., *Rubus triflorus* Rich., *Brunella vulgaris* L. and *Agrimonia eupatoria* L. Madison; La Crosse, Pammel.

46. SPHAEROTHECA PANNOSA (Wall.).

On *Rosa parviflora* Ehr., and on cultivated roses.

The mildew, or mycelium bearing conidia, is very common through the summer and fall, injuring some of the moss-roses very greatly. The perithecial fruit, on the contrary, is uncommon, and seems to form preferably on wild roses, rather late in the fall.

47. ERYSIPHE TORTILIS (Wall.).

On leaves of *Clematis virginiana* L., in summer and fall. Madison; Devil's Lake, Pammel.

No. 558 of Ellis' North American Fungi, on the same host, distributed under the name of *Erysiphe communis* Schl., seems to belong to this species.

48. ERYSIPHE LAMPROCARPA (Wall.).

Very common, on *Ambrosia artemisiaefolia* L., *Helianthus strumosus* L., *Aster miser* L., *A. laevis* L., *Xanthium strumarium* L., *Cnicus discolor* Muhl., *Diplopappus umbellatus* T. & G., *Eupatorium perfoliatum* L., *E. purpureum* L., *Phlox paniculata* L., *P. drummondii* Hook., *Teucrium canadense* L., *Hydrophyllum virginicum* L., *Echinospermum virginicum* Lehm. and *Verbena urticifolia* L.

49. ERYSIPHE COMMUNIS (Wall.).

On *Ranunculus abortivus* L., *Lathyrus venosus* Muhl. and *Amphicarpaea monoica* Nutt. Madison.

Conidia, apparently of this species, are also very common on *Thalictrum dioicum* L.

50. ERYSIPHE GRAMINIS D C.

On *Poa pratensis* L. Madison. Common, through the season, in shaded places.

Only the conidia (*Oidium monilioides* Lk.) have been found, but there can be little doubt that they belong to this species, the perithecial fruit of which forms most frequently on the old leaves.

PYRENOMYCETES.

51. PHYLLACHORA LESPEDEZAE (Schw.) (*Dothidea lespedezae*, Schw.).

On leaves of *Lespedeza capitata* Michx., in summer. La Crosse, and Hokah, Minn., Pammel.

52. PHYLLACHORA PTERIDIS (Reb.) (*Dothidea pteridis* Fr.).

The Pycnidia occur on fronds of *Pteris aquilina* L., from Milwaukee, in the Lapham herbarium.

53. PHYLLACHORA ULMI (Duv.) (*Dothidea ulmi* Fr.).
Very common on leaves of *Ulmus americana* L., in fall and winter, the ascospores forming on the fallen leaves; the spermogonia (*Septoria ulmi* Fr.) on the same host.

54. PHYLLACHORA TRIFOLII (Pers.) (*Dothidea trifolii* Fr.).
With its conidia (*Polythrincium trifolii* Kze.), on *Trifolium repens* L. and *T. pratense* L. Common, in summer and fall. Madison, Ithaca; La Crosse, Pammel; Sauk City, Lüders.

55. PHYLLACHORA GRAMINIS (Pers.) (*Dothidea graminis* Fr.).
Common, on *Asprella hystrix* Willd., *Dactylis glomerata* L., *Elymus canadensis* L., *Panicum latifolium* L. and other grasses, in fall and winter. Madison, Ithaca; La Crosse, Pammel.

56. MONTAGNELLA HELIOPSIDIS (Schw.) (*Dothidea heliopsidis* Schw.).
What appears to be this species was found on the dead stems of species of *Helianthus* and *Aster*, but sterile, as usual.

57. PARODIELLA PERISPORIOIDES (B. & C.) (*Dothidea perisporioides* B. & C.)?
On leaves of *Desmodium acuminatum* D C. La Crosse, Pammel.

What I have referred to this species appears as numerous minute olive-brown or black dots, .5 mm. or less in diameter, on the upper surface of the leaves. These perithecia are smaller than those of any form of *P. perisporioides* in my herbarium, and are pycnidial, containing numerous hyaline round-oblong stylospores, each measuring 3–5μ, and with 1–2 oil globules.

58. HYPOMYCES LACTIFLUORUM (Schw.).
Very common on one or more species of agaric, deforming the infested plants, which are ultimately covered closely by the bright cinnabar-red perithecia.

59. GNOMONIELLA FIMBRIATA (Pers.) (*Sphaeria fimbriata* Pers.).
On leaves of *Carpinus americana* Michx., in August. Pycnidia (*Glaeosporium carpini* Desm.) and ascosporic fruit.

60. GNOMONIELLA CORYLI (Batsch) (*Sphaeria coryli* Batsch).
On leaves of *Corylus americana* Walt. and *C. rostrata* Ait., in summer. La Crosse, Kirkland, and Hokah, Minn., Pammel.

61. PLOWRIGHTIA MORBOSA (Schw.) (*Sphaeria morbosa* Schw.).
Common, on stems of *Prunus virginiana* L., *P. americana* Marshall, *P. pennsylvanica* L. and *P. serotina* Ehrh. Madison; Sauk City, La Crosse, Pammel.

In May, when conidia are abundant on the forming knots, those of the preceding year commonly have the protoplasm of their asci still undiffer-

entiated into spores. A considerable number of specimens show that the species winters very largely by its perennial mycelium rather than by ascospores, and new knots are usually formed close below the old ones by the same mycelium. The "black knot" undoubtedly also occurs on cultivated species of *Prunus*, though I have not yet collected it on them.

62. NECTRIA CINNABARINA (Tode).

On branches of *Robinia pseudacacia* L. Madison.

This with its conidia, *Tubercularia vulgaris* Tode, has been collected only on dead branches; but it has been shown by Dr. Heinrich Mayr (Part 3 of Hartig's Untersuchungen aus dem forstbotan. Institut zu München), that the species sometimes lives as a true parasite on maple, box-elder, etc.

63. CRYPTOSPORELLA ANOMALA (Pk.) (*Diatrype anomala* Peck).

Forming knots on branches of *Corylus americana* Walt. Madison.

64. EPICHLOE TYPHINA (Pers.).

On sheaths of an *Elymus*, *Andropogon furcatus* Muhl. and one other undetermined grass. Madison, Stoughton, Ithaca; La Crosse, Pammel.

65. CLAVICEPS PURPUREA (Fr.)?

Common on *Secale cereale* L., and *Triticum vulgare* Vill. Syene; La Crosse, Pammel.

The sclerotia were not subjected to cultures, and consequently no perithecia were obtained, but there can be little doubt as to the species.

66. CLAVICEPS, sp.

On *Zizania aquatica* L. Milwaukee, Lapham.

The sclerotia are stout, ovoid, oblong, averaging 5×9 mm. Their color is pinkish, brown. I have seen the same thing in the herbarium of Dr. Farlow, but do not know that it has ever been made to fruit.

67. CLAVICEPS, sp.

Small sclerotia have been found in abundance on *Elymus striatus* Willd., *E. canadensis* L., *Koeleria cristata* Pers., *Glyceria nervata* Trin., *Agrostis scabra* Willd., *Deyeuxia canadensis* Beauv., *Poa compressa* L. and *Phleum pratense* L., at Madison, Ithaca, La Crosse and Kilbourn City, by Mr. Pammel and myself. No cultures having been undertaken, however, the species is undetermined.

68. CORDYCEPS MILITARIS (L.) (*Torrubia militaris*, Fr.)?

Conidia on "white grubs" in fall. Madison.

Only the *Isaria* stage was seen, although a number of cultures were undertaken.

69. ———.

On leaves of *Eupatorium ageratoides* L. and *Podophyllum peltatum* L.

Stroma sessile, 3 mm. in diameter, hemispherical, waxy, pale flesh-colored Perithecia superficial. Asci and spores as in *Epichloe typhina* (P.).

A curious fungus, related to *Cordyceps* and *Epichloe*, apparently growing on clusters of spiders' eggs. Possibly connected with *Isaria arachnophila*, No. 76.

PHACIDIACEAE.

70. PHACIDIUM RANUNCULI Desmaz.

On leaves of *Ranunculus pennsylvanicus* L. and *R. sceleratus* L. Madison; La Crosse, Pammel.

Flesh-colored; not dark like English specimens, but otherwise similar to them.

71. PHACIDIUM TRIFOLII (Bernh.).

On leaves of *Trifolium pratense* L. Madison.

72. RHYTISMA SALICINUM Fr.

On leaves of *Salix*. Madison.

73. RHYTISMA ASTERIS Schw.

On leaves of *Solidago*. Sauk City, Lüders. Also found on one or more species of *Aster*, at Brownsville, Minn., by Mr. Pammel.

The compound nature of these galls is discussed in volume IV. of "Psyche."

74. RHYTISMA ILICIS CANADENSIS Schw.?

On leaves of *Ilex verticillata* Gray. Milwaukee, Lapham; Devil's Lake, La Crosse, Pammel.

Forming round or somewhat irregular black spots, about 2 mm. in diameter, surrounded by a brown border, on the upper surface of the leaf—whitish below. The same form occurs on leaves of *I. laevigata* Gray, collected at Ovid, N. Y., by Brewer and Chickering; but all of my specimens are immature.

DISCOMYCETES.

75. PEZIZA DEHNII Rabh.

On petioles and leaves of *Potentilla norvegica* L., in spring and summer. Madison; La Crosse, Pammel.

ISOLATED IMPERFECT FORMS.

76. ISARIA ARACHNOPHILA Ditm.

On spiders, in autumn. Madison. (*Cf.* No. 69).

77. MICROSTROMA LEUCOSPORUM Mont.

Forming white spots on the under surface of leaves of *Juglans cinerea* L. Represented from just across the line in Minnesota and Illinois, and hence certain to be found in Wisconsin. It should also occur on *Carya*.

78. DIDYMARIA UNGERI Cda. (*Ramularia didyma* Ung.).

On *Ranunculus fascicularis* Muhl., *R. recurvatus* Poir. and *Anemone dichotoma* L. Madison: Kirkland, La Crosse, Pammel.

79. RAMULARIA CELASTRI Ell. & Martin. (*R. celastri* Pk.).

On leaves of *Celastrus scandens* L., in fall. Madison.

Spores 1-4 celled. Described under the same name by Peck (33 Report, p. 30).

80. RAMULARIA PLANTAGINIS Ell. & Martin.

On leaves of *Plantago major* L. Madison, Syene; Kirkland, Pammel.

81. RAMULARIA TULASNEI Sacc. (*R. fragariae* Pk.).

On leaves of *Fragaria vesca* L. and *F. virginiana* Ehr., wild and cultivated. Madison; Milwaukee, Trowbridge; Janesville, Kellogg.

Known pretty generally over the country as "Strawberry Rust."

With us this species appears to pass the winter in black, stromatoid sclerotia, which protrude from the surface of the leaf. In the spring conidial threads grow out from these bodies and quickly fruit.

82. RAMULARIA ARVENSIS Sacc.

On leaves of *Potentilla norvegica* L. Madison, Syene; La Crosse, Pammel.

83. RAMULARIA MACROSPORA Fres., var. SENECIONIS Sacc.

On leaves of *Aster novae angliae* L. Syene.

To the naked eye resembling the conidia of *Entyloma compositarum* Farl. Spores colorless, 1–4 celled, usually 2–celled; oblong-ovoid, slightly truncate at the pointed extremities, sometimes narrowed gradually to the septum; 5–6$\times$20–40 μ.

84. RAMULARIA ARMORACIAE Fckl.

Common on leaves of *Nasturtium armoracia* Fr., wild and cultivated. Madison.

The common leaf disease of the horseradish, very destructive to the old leaves in summer and fall. Presumably occurring on other Cruciferae in Wisconsin, as it does elsewhere.

85. RAMULARIA URTICAE Ces.

On *Urtica gracilis* Ait., in spring. Madison.

Agrees closely with Berlin specimens from Magnus.

86. OVULARIA OBLIQUA (Cke.) (*Ramularia obovata* Fckl., *Peronospora obliqua* Cke.).

Common, in spring, on leaves of *Rumex*. Madison.

87. OVULARIA IRREGULARE (Pk.) (*O. isarioides* Sacc., *Oidium irregulare* Pk.).

On the fruit of *Staphylea trifolia* L. La Crosse, Pammel.

88. OVULARIA PYROLAE, n. sp.

On leaves of *Pyrola rotundifolia* L. Stoughton.

Spots circular, dark. Spores colorless, round-oval to oblong, frequently acute at one end, unicellular. Usually $4 \times 12\ \mu$; extremes noted: $3.5\text{–}6 \times 6\text{–}17\ \mu$.

89. FUSIDIUM RAVENELIANUM Thuem. (*Ramularia desmodii* Cke., *Fusisporium pubescens* B. & C.).

On leaves of a species of *Desmodium* and an *Astragalus*. Madison; La Crosse, Pammel.

90. FUSIDIUM PTERIDIS Kalchbr.

On fronds of *Aspidium marginale* Sw. Kirkland, Pammel.

91. CERCOSPORELLA CANA (Pass.) (*Fusidium canum* Pass.).

Common, on leaves of *Erigeron canadense* L., in summer and fall. Madison.

What appears to be the same thing was found at La Crosse on the radical leaves of some *Solidago*.

92. CERCOSPORELLA APOCYNI E. & K.

On leaves of *Apocynum cannabinum* L. La Crosse, Pammel.

93. CERCOSPORA APII Fres., var. PASTINACAE Farlow, *in herb.*

Common, on leaves of *Pastinaca sativa* L. Madison; La Crosse, Pammel.

Perhaps from *Cercosporella pastinacae* Karst., as described in Hedwigia, 1884, p. 63, is not distinct.

94. CERCOSPORA BETAECOLA Sacc.

On *Beta vulgaris* L. Ithaca.

Very destructive to beet leaves, in fall.

95. CERCOSPORA CHENOPODII Fres.

Very abundant, on leaves of *Chenopodium album* L., in midsummer and later. Madison; La Crosse, Pammel.

96. CERCOSPORA RACEMOSA Ell. and Mart., *ined.*

On *Teucrium canadense* L. La Crosse, Pammel.

Scarcely a good *Cercospora*. I am indebted to Dr. Farlow for the determination.

97. CERCOSPORA PHYSALIDIS Ell.

On leaves of two species of *Physalis*. La Crosse, Pammel.

98. CERCOSPORA PYRI Farlow.

On leaves of *Pyrus arbutifolia* L. Kilbourn City, Pammel.

99. CERCOSPORA GRANULIFORMIS Ell. & Holway.

On leaves of *Viola cucullata* Ait. Madison; La Crosse, and Hokah, Minn., Pammel.

Polythrincium trifolii Kze.—See Phyllachora trifolii, No. 54.

99*a*. CLADOSPORIUM TRIOSTEI Pk., n. sp.

On leaves of *Triosteum perfoliatum* L. La Crosse, Pammel.

Spots indefinite, pale, becoming brown at the center with age; 2–5 mm. in diameter. Conidiophores tufted, slightly wavy, hypophyllous, 125–150μ long, 3.5μ in diameter, deep brown. Spores dark brown, sometimes slightly paler than the threads; lemon-shaped, with strongly pronounced papillae at either end; 2-celled; 5–7$\times$15–20μ. Septum usually central, sometimes near one end.

100. PASSALORA DEPRESSA (B. & Br.) (*Cladosporium depressum* B. & Br.).

On leaves of *Zizia integerrima* D C. and *Archangelica atropurpurea* Hoffm.? La Crosse, Pammel.

101. FUSICLADIUM DENDRITICUM (Wall.) (*Cladosporium dendriticum* Wall.).

On leaves and fruit of *Pyrus malus* L., *P. coronaria* L. and *P. prunifolia* L. Madison, Ithaca; Baraboo, Johnson; La Crosse, Pammel; and reported all over the state.

The cause of "leaf-blight" and "scab" of apples, and very destructive.

102. PYRICULARIA GRISEA (Cke.) (*Trichothecium griseum* Cke.).

On the leaves of *Panicum sanguinale* L. Syene, Madison.

Causing gray spots; common, in the fall.

103. TRICHOTHECIUM ROSEUM Fr.

On a living puff-ball in August. Madison.

Very possibly growing as a saprophyte on an injured part of the fungus, as it occurs the year round on firewood, old black-knots of cherry, etc.

104. SEPEDONIUM CHRYSOSPERMUM Link.

On a species of *Boletus*. Madison.

Although the host was almost entirely replaced by the conidia, as usual, there was no indication of ascosporic fruit.

105. ASTERINA, sp. (?).

On leaves of *Salix*, in fall. Syene.

Forming dendritic black spots several millimeters in diameter. Too immature for determination.

106. SPHAERONEMA PERSICAE (Schw.).

On *Plowrightia morbosa* Schw., and on branches of *Prunus americana* Marsh. Madison.

Perhaps growing on the honey-dew of Aphides.

107. GLAEOSPORIUM LINDEMUTHIANUM Sacc. & Magn.

On pods of *Phaseolus*, sp. Madison.

Causing the common and destructive spotting of wax beans.

108. GLAEOSPORIUM (MARSONIA) MELILOTI, n. sp.

On the stems of *Melilotus alba* Lam. Madison.

Perithecia minute, inconspicuous, occurring in longitudinal rows 2-5 mm. long, on the stem. Spores oozing out in pale, flesh-colored tendrils, under the microscope appearing colorless; oblong, straight or slightly curved, 2-celled. 5-6×13-20 μ. In the smaller spores the septum is nearly central; in the larger ones it occurs nearer one end.

109. GLAEOSPORIUM (MARSONIA) JUGLANDIS (Lib.).

On brown spots on leaves of *Juglans nigra* L. and *J. cinerea* L. Madison; La Crosse, and Hokah, Minn., Pammel.

Almost entirely defoliating some trees in August.

109*a*. GLAEOSPORIUM (MARSONIA) CASTAGNEI (Desm. & Mont.).

On leaves of *Populus alba* L. Madison.

Glaeosporium carpini Desmaz.—See Gnomoniella fimbriata, No. 59.

110. PHOMA UVICOLA B. & C.

On cultivated species of *Vitis*. Syene; Ithaca, Hatch.

The apparant cause of much of the "dry rot" of grapes. The form sent by Mr. Hatch is reported as very destructive to the young twigs of some varieties, and appears to be identical with that distributed in Erb. Critt. Ital., No. 747.

111. PHYLLOSTICTA SPHAEROPSOIDEA Ell. & Everh.

On leaves of *Aesculus hippocastanum* L. Madison.

112. PHYLLOSTICTA VITICOLA (Cke.).

On leaves of cultivated grape and *Ampelopsis quinquefolia* Mich. Madison, Ithaca.

113. PHYLLOSTICTA DODECATHEI, n. sp.

On leaves of *Dodecatheon meadia* L. Stoughton.

Spots circular, brown, about 3 mm. in diameter. Spores hyaline, ovoid to oblong, sometimes nearly spherical, eguttulate, 2-5×3.5-7 μ, unicellular.

114. PHYLLOSTICTA QUERCUS Sacc. & Sp.

On leaves of *Quercus macrocarpa* Michx. and *Q. alba* L. Kirkland, La Crosse, Pammel.

115. PHYLLOSTICTA APOCYNI, n. sp.

On leaves of *Apocynum cannabinum* L. La Crosse, Pammel.

Spots circular, brown, about 3 mm. in diameter. Perithecia small, black. Spores colorless, oblong, 3.5–4×5–7 μ, unicellular.

116. PHYLLOSTICTA PYRINA Sacc.

On apple leaves, Madison.

117. PHYLLOSTICTA, sp.

On leaves of *Prunus serotina* Ehrh. Madison.

Spots rounded or oblong, 3–8 mm. in diameter, brownish-red. Perithecia small, black. Spores ellipsoidal, hyaline, 2–4×7–8 μ, unicellular.

Perhaps *P. serotina* Cke., of which I have not been able to examine specimens.

118. ASCOCHYTA, sp.

On leaves of *Silphium integrifolium* Mich. and *Vernonia noveboracensis* Willd. Stoughton; La Crosse, Pammel.

Spots brown, circular, about 3 mm. in diameter. Perithecia brown, 100–120μ, slightly carbonized about the round orifice. Spores colorless; ovoid, oblong or reniform, frequently constricted at the middle; 3–5×7–14μ, with 2–4 oil drops; when mature 2-celled.

Resembles *Phyllosticta sonchi* Sacc. (Michelia, I, 141), except in the septate spores.

119. ASCOCHYTA OXYBAPHI, n. sp.

On leaves of *Oxybaphus nyctagineus* Sweet. Stoughton.

Spots dark brown, roundish, 1–2 mm. Perithecia on the upper surface of the leaf, small, brown, carbonized about the orifice. Spores colorless, 2-celled, 4×10–17μ; sometimes constricted at the middle.

120. ASCOCHYTA VIOLAE Sacc. and Sp.

On leaves of *Viola pubescens* Ait. Madison.

121. ASCOCHYTA QUERCUS Sacc. & Sp.

On leaves of species of *Quercus*; on round, white spots. Madison.

121*a*. ASCOCHYTA AMPELINA Sacc.

On small brown spots, on leaves of *Vitis cordifolia* Mx. Madison.

122. ASCOCHYTA SPARTINAE, n. sp.

On leaves of *Spartina cynosuroides* Willd., in autumn. Madison; La Crosse, Pammel.

This species was found in small quantity, in company with *Uromyces acuminatus* Arthur, and causes small rounded pale yellow spots on the leaves. The spores ooze out in flesh-colored masses, and are colorless, straight or slightly curved, usually a little narrower at one end than the other. They average 3×35 μ. As a rule they are two-celled, but in a few

instances two or even three septa were distinguished. Perhaps identical with some of the numerous described Septoriae or Ascochytae of grasses; but I have been unable to place it.

123. ASCOCHYTA SALICIFOLIAE, n. sp.

On leaves of *Spiraea salicifolia* L. La Crosse, Pammel.

Spots numerous, rounded, about 1 mm. in diameter, deep flesh colored. Perithecia large, similarly colored. Spores oozing out; hyaline, fusiform, usually a little curved in form of a crescent, 1-septate, with several (3-4) oil drops; 2-3.5×30-50 μ.

Referred at first to *Septoria ascochytoides* Sacc., but differs in the absence of a darker border to the spots, while the spores are twice as long as in that species, where they are said to measure 18-20×2.5-3 μ. Perhaps, like the last, more properly a Septoria than an Ascochyta.

124. SEPTORIA RAVENELII THUEM.

On leaves of *Prunus serotina* Ehrh. La Crosse, Pammel.

This occurs in the Curtis herbarium under the name *S. sanguinea* Desm.

125. SEPTORIA NOLI TANGERIS Gerard.

Forming small black spots on cotyledons of *Impatiens fulva* Nutt. Madison.

126. SEPTORIA SISYMBRII Ellis.

On leaves of *Dentaria laciniata* Muhl., in spring. Madison.

127. SEPTORIA ALLIORUM Westd. (*S. viride tingens* Curtis).

On leaves of *Allium triceccum* Ait., in spring. Madison.

With more distinct spots than the specimens described in Peck's 23d Report, p. 55.

128. SEPTORIA RIBIS Desmaz.

On leaves of *Ribes cynosbati* L. and *R. floridum* L. Madison; La-Crosse, Pammel.

129. SEPTORIA VIOLAE West.

On leaves of *Viola pubescens* Ait. Madison.

130. SEPTORIA ERIGERONTIS B. & C., *in herb.* Curtis (*S. erigerontis* Peck).

On radical leaves of some *Erigeron*, in early spring. Madison.

131. SEPTORIA OENOTHERAE West.

On leaves of *Oenothera biennis* L. Madison.

132. SEPTORIA SCROPHULARIAE Peck.

On leaves of *Scrophularia nodosa* L. Madison; La Crosse, Pammel.

133. SEPTORIA HETEROCHROA Desmaz.

On leaves of *Malva rotundifolia* L. Common, Madison.

Also frequently referred to *S. destruens* Desm., by authors.

134. SEPTORIA CANNABINA West.

On leaves of *Cannabis sativa* L., in autumn, Madison. Sometimes accompanied by a *Phoma*.

The diseased hemp leaves were marked by discolored spots very early in the season, but little fruit was formed.

135. SEPTORIA ACERIS (Libert).

On leaves of *Acer dasycarpum* Ehrh. Madison.

A comparison with the original *Ascoxyta aceris* Lib. (Crypt. Ard., No. 54), for which I am indebted to Dr. Farlow, shows very little difference between our plant and the European form. The spores, after their escape, lie loosely over the lower surface of the leaves. In both forms they are straight or more commonly somewhat curved, usually 4-celled, and decidedly constricted at the septa, which, like the external walls, are very thin. The average size is 4×40–$50\ \mu$. Spots very small, yellow.

136. SEPTORIA ASTRAGALI Desmaz.

On leaves of *Vicia americana* Muhl. Stoughton.

137. SEPTORIA, sp.

On leaves of *Aquilegia canadensis* L. La Crosse, Pammel.

Spots blackish, elongated. Spores filiform, $1 \times 25\ \mu$ Differs from *S. anemones* Desm. chiefly in the spots. Penzig and Saccardo (Atti R. Inst. Veneto, Ser. 6, v. 2.) describe a species under the name *S. aquilegiae*, which produces large black spots on leaves of *Aquilegia atrata*, which is possibly the same, though I have seen only the abstract of their paper in the Bot. Centralblatt, where spore-measurements are not given.

138. SEPTORIA COPTIDIS B & C.

On leaves of *Coptis trifolia* Salisb. Wisconsin, Lapham. *In herb.* Curtis.

139. SEPTORIA PHLOCIS Sacc. & Sp.

On leaves of *Phlox divaricata* L. Madison.

Differs from the typical form in causing larger yellowish or dirty white spots 5 mm. in diameter, which are often confluent. Perithecia numerous. Spores colorless, filiform, 2×30–$40\ \mu$, usually 2-septate.

140. SEPTORIA GRAMINUM Desm.

On leaves of *Setaria viridis* Beauv. and on *Poa annua* L. Ithaca, Syene, Stoughton.

The variety on *Poa* is quite destructive in spring, occurring on the rachis of the panicle and on the floral envelopes, which are uniformly brown. Perithecia round, black, about 80 μ in diameter, prominent. Spores hyaline, slightly clavate, obscurely septate; average size, $2.5 \times 40\ \mu$.

141. SEPTORIA RUBI (Duby).

On leaves of *Rubus strigosus* Mich. Madison, Syene.

142. SEPTORIA CONVOLVULI Desmaz. (*S. flagellaris* Ell. & Everh.)
On leaves of *Convolvulus sepium* L. Madison.

Spots brown or nearly white, round, 1–3 mm. in diameter. Perithecia small, one or a few on each spot. Spores nearly filiform, colorless, usually 2×40 μ. Not certainly distinguishable from forms of *S. convolvuli*, which varies much on different hosts.

143. SEPTORIA, sp.
On leaves of *Silphium integrifolium* Mich. Stoughton.

Spots angular, blackish-brown, 1-3 mm. in diameter. Perithecia inconspicuous, 60–70 μ. Spores colorless, filiform, about 5-septate, 1.5–2×30–35 μ.

144. SEPTORIA, sp.
On stem of *Ribes*. "Wisconsin, Lapham." *In herb.* Curtis.

145. SEPTORIA POLYGONORUM Desmaz.
On *Polygonum hydropiper* L. Ithaca, Madison; Baraboo, Pammel.

Septoria ulmi Fr.—See Phyllachora ulmi, No. 53.

146. DARLUCA FILUM Cast.
On various Uredineae; e. g., *Puccinia polygoni amphibii*, on *Polygonum amphibium*, *P. asteris* on *Aster*, *Uromyces junci*, on *Juncus*, *U. acuminatus*, on *Spartina*, *Puccinia tomipara*, on *Bromus*, *Phragmidium*, on *Potentilla*, *Uredo iridis*, on *Iris versicolor* and *Puccinia menthae*, on *Pycnanthemum*.

BASIDIOMYCETES.

UREDINEAE.

147. UROMYCES TEREBINTHI (D C.) (*Pileolaria brevipes* B. & Rav.).
Uredo and teleutospores on *Rhus toxicodendron* L. Madison; La-Crosse, Pammel.

I have not compared this with the European form, but Shroeter has shown that they are identical (Hedwigia, 1875, p. 170).

148. UROMYCES POLYGONI (Pers.).
Uredo and teleutospores on *Polygonum aviculare* L. and *P. erectum* L., in summer and fall; the uredo especially abundant. Madison; La Crosse, Pammel.

149. UROMYCES PHASEOLI (Pers.) (*U. appendiculatus* Lév.).
Uredo and teleutospores on leaves of cultivated beans (*Phaseolus*) and *Amphicarpaea monoica* Nutt. The aecidium on the latter host.

150. UROMYCES OROBI (Pers.).

Aecidium on *Lathyrus venosus* Muhl., *L. palustris* L. and *Desmodium acuminatum* D C. Uredo and teleutospores on *L. venosus* Muhl. Madison; Baraboo, La Crosse, Pammel. The aecidium on *Desmodium*, from Brownsville, Minn.

151. UROMYCES LESPEDEZAE (Schw.) (*U. macrosporus* B. & C.).

Aecidium, uredo and teleutospores on *Lespedeza capitata* Michx Madison; Kilbourn City, La Crosse, Pammel.

152. UROMYCES TRIFOLII (A. & S.) (*U. apiculatus* Strauss).

Aecidium, uredo and teleutospores on *Trifolium repens* L. and *T. incarnatum* L. Madison; La Crosse, Pammel.

152*a*. UROMYCES EUPHORBIAE C. & P.

Aecidium, uredo and teleutospores on *Euphorbia maculata* L. and *E. hypericifolia* L., very common in late summer and fall. Madison; La Crescent, Minn., Pammel.

The aecidium has been distributed by Cooke, on the same host plant, as *A. euphorbiae* Pers. (Ravenel's Fung. Amer., No. 484).

153. UROMYCES ERYTHRONII (D C.) (*U. liliacearum* Ung.).

Aecidium, uredo and teleutospores on *Lilium canadense* L. Madison; La Crosse, Pammel.

The uredo corresponds in every respect with that described by Dr. Farlow in the Proceedings of the American Academy, XVIII., p. 79.

154. UROMYCES JUNCI (Desmaz.).

Uredo and teleutospores on a small *Juncus*. Madison, Syene.

155. UROMYCES HEDYSARI PANICULATI Schw.

Uredo and teleutospores on a species of *Desmodium*. Madison.

156. UROMYCES PYRIFORMIS Cke.

Uredo and teleutospores on *Acorus calamus* L. La Crosse, Pammel.

157. UROMYCES CALADII (Schw.).

Aecidium, uredo and teleutospores on leaves of *Arisaema triphyllum* Torr. Madison; Kirkland. Pammel.

Peck has given the synonymy of this species in full in the 29th Report on the New York Cabinet of Natural History, p. 67.

158. UROMYCES HYPERICI (Schw.).

Aecidium on *Elodes virginica* Nutt. Teleutospores on *Hypericum pyramidatum* Ait. La Crosse, Pammel.

159. UROMYCES SOLIDAGINIS Niessl.

Teleutospores on *Rudbeckia laciniata* L. La Crosse, Pammel.

160. UROMYCES ACUMINATUS Arthur.

Uredo and teleutospores on *Spartina cynosuroides* Willd. Madison; La Crosse, Pammel.

A very variable species, which in some of its forms can scarcely be distinguished from a species on several grasses from other parts of the country, which may be a form of the variable *U. dactylidis* Otth.

161. PUCCINIA CIRCAEAE Pers.

Teleutospores very abundant on leaves of *Circaea lutetiana* L. Madison; La Crosse, Pammel; also collected at Hokah, Minn., by Mr. Pammel.

162. PUCCINIA ANEMONES VIRGINIANAE Schw. (*P. solida* Schw.).

Teleutospores on *Anemone virginiana* L. and *A. cylindrica* Gray, in August. Madison; La Crosse, and Hokah, Minn., Pammel.

163. PUCCINIA THALICTRI Chevall.

Teleutospores on *Thalictrum dioicum* L. and *T. cornuti* L. Madison; Kirkland, La Crosse, Pammel.

I do not see how this can be distinguished morphologically from *P. anemones* Pers. It is usually marked with larger and more obtuse warts than our specimens of the latter, but European specimens of *P. anemones* sometimes have quite as coarse granulations as our *P. thalictri*.

164. PUCCINIA HYDROPHYLLI Peck & Clinton.

Teleutospores on *Hydrophyllum virginicum* L. Madison.

165. PUCCINIA LOBELIAE Ger. (*P. microsperma* B. & C.).

Teleutospores on *Lobelia syphilitica* L., in August. Madison.

166. PUCCINIA VERRUCOSA (Schultz). (*P. hyssopi* Schw.).

Teleutospores on *Lophanthus scrophulariaefolius* Benth. La Crosse, Pammel.

167. PUCCINIA SILPHII Schw.

Teleutospores on *Silphium perfoliatum* L. and *S. integrifolium* Mich. Stoughton; La Crosse, Pammel.

On the latter host sometimes accompanied by the spermogonia of an aecidium, in June. (*cf.* No. 242.)

168. PUCCINIA ASTERIS Duby. (*P. asteris* Schw.).

Teleutospores on *Aster corymbosus* Ait., *A. cordifolius* L. and *A. tradescanti* L. La Crosse, Dells of the Wisconsin, Pammel.

169. PUCCINIA SOLIDAGINIS Pk.

On leaves of *Solidago nemoralis* Ait. (?) La Crosse, Pammel.

Paler than the type, which it otherwise resembles, according to Professor Peck.

The teleutospores are often forked; in some cases the division extends merely through the terminal papilla; in others the lower cell is produced into a thickened papilla just below the septum.

170. PUCCINIA TOMIPARA, n. sp.

Uredo and teleutospores on a species of *Bromus*, apparently *B. ciliatus* L. La Crosse, Pammel.

II. Sori small, round, or little elongated, on the upper surface of the leaf. Spores commonly round, somewhat roughened with blunt, inconspicuous warts; pale yellow, 22–26 μ.

III. Sori compact, black, long covered by the epidermis; round or slightly elongated, usually about .2 mm. in diameter. Spores pale chestnut-brown, thin walled, without apical thickening; irregularly oblong, sessile; 2–5-celled, often tomiparous; 13–22×35–43 μ.

The species is remarkable from the fact that the spores are commonly 3–4-celled, with the uppermost septum oblique or not infrequently parallel to the axis of the spore, which is thus made to consist of more than one row of cells. It somewhat resembles *P. triarticulata* B. & C., which occurs on *Elymus*, and which has 3-celled spores; but these are longer and differently shaped.

171. PUCCINIA BARYI (B. & Br.) (*P. striatula* Thuem., *P. linearis* Pk.).

Uredo and teleutospores on some dead grass, possibly *Andropogon scoparius* Michx. Madison.

Well marked by the strongly clubbed paraphyses.

172. PUCCINIA ANDROPOGI Schw. (*P. ellisiana* Thuem.).

Teleutospores on *Andropogon scoparius* Mx. Madison; Milwaukee, Lapham; La Crosse, Pammel.

This has been compared with Schweinitzian specimens, by Dr. Farlow. The teleutospores are not unlike those of *P. cesati* Schr., as described by Winter.

173. PUCCINIA ARUNDINARIAE Schw.

Teleutospores on dead leaves of *Spartina cynosuroides* Willd., in winter and spring. Madison.

174. PUCCINIA EMACULATA Schw. (*P. graminis* P., var. *brevicarpa* Peck).

Teleutospores on *Panicum capillare* L. Madison; La Crosse, Pammel.

175. PUCCINIA VEXANS Farlow.

The form described by Peck as *Uromyces brandegeei*, but now held to be the uredo or mesosporic form of this species, was found once on *Bouteloua racemosa* Lag., at La Crosse, by Mr. Pammel. The quantity examined was small, and no teleutospores were seen.

176. PUCCINIA PHRAGMITIS (Schum.) (*P. arundinacea* Hedw.).

Uredo and teleutospores on *Phragmites communis* Trin. Milwaukee, Lapham; La Crosse, Pammel. Also collected at Hokah, Minn., by Mr. Pammel.

177. PUCCINIA MAYDIS Carrad. (*P. sorghi* Schw.).

Uredo and teleutospores on the leaves of *Zea mays* L., common, in summer and fall. Madison.

Cooke has described an Asiatic species on Indian Corn, under the name of *P. purpurea*, the teleutospores of which do not appear distinct from ours. The purplish discoloration of the leaves which it induces, and from which it derives its specific name, is not characteristic, for some of the Wisconsin specimens of *P. maydis* occur on decidedly purplish spots, and Dr. Farlow informs me that Italian specimens of the same species are often purple. An examination of Indian specimens of *P. purpurea*, for which I am indebted to Dr. Farlow, shows, however, that the uredo spores are rather larger and more oblong than those of our plant; and they are accompanied by nearly colorless, thick-walled, clavate paraphyses, which are wanting in our species.

178. PUCCINIA POLYGONI AMPHIBII Pers. (*P. polygonorum* Lk., *P. amphibii* Fckl.).

Uredo and teleutospores on *Polygonum amphibium* L. Madison; La-Crosse, Pammel. Also collected at Brownsville, Minn., by Mr. Pammel.

The parasite is very commonly attacked and greatly deformed by *Darluca filum* Cast.

179. PUCCINIA PRUNI SPINOSI (P.) (*P. prunorum* Link).

Uredo and teleutospores on leaves of seedling *Prunus americana* Marsh. and on those of older plants of the same species and of *P. virginiana* L., in late summer and fall. Madison.

180. PUCCINIA ARGENTATA (Schultz) (*P. noli tangeris* Cda.).

Uredo and teleutospores on *Impatiens fulva* Nutt., in fall. Madison.

As no aecidium accompanies this species in Europe, our *Aecidium impatientatum* Schw. must be considered as probably belonging to some heteroecismal species, although it occasionally occurs on the same leaves with the *Puccinia*.

P. argentata has also been found on *Impatiens pallida* Nutt., at Hokah, Minnesota, by Mr. Pammel.

181. PUCCINIA AMORPHAE Curtis.

Uredo and teleutospores on leaves of *Amorpha canescens* Nutt. and *A. fruticosa* L., common. Madison; La Crosse, Pammel. Also collected at Hokah, Minn., by Mr. Pammel.

182. PUCCINIA PETALOSTEMONIS Farlow, *in litt.*

Uredo and teleutospores on *Petalostemon.* La Crosse, Pammel.

II. Sori round, brown, surrounded by the ruptured epidermis, which is elevated so as to form a false-peridium. Spores pale brown, ovoid, nearly smooth or somewhat granular on the surface. Average size, 20×22 μ.

III. Sori similar to those containing uredo spores, black. Spores medium brown, broadly ellipsoidal, slightly constricted, thin-walled, without apical thickening, surrounded by a smooth gelatinous sheath; average 20×33 μ.

The species is related to *P. amorphae* Curt., but readily distinguished by the paler and more transparent teleutospores, and the thinner, smooth envelope. Pale-amber paraphyses, frequently hooked at the tip, accompany both uredo and teleutospores.

183. PUCCINIA ZYGADENI, n. sp.

Teleutospores on *Zygadenus glaucus* Nutt. La Crosse, Pammel.

Sori small, rounded; on both sides of the leaf. Spores amber-brown, darker at the apex, on thin walled colorless pedicels; oblong or sometimes clavate; but slightly constricted. Apex thickened, usually rounded or truncate, rarely acute. 16–20×33–56 μ; commonly about 17×43 μ.

This resembles a specimen in the Curtis herbarium, on *Amianthium,* which is labeled *P. asphodeli* Duby. "It corresponds closely to a specimen from France, bearing the same name, but evidently incorrectly named, as other specimens from France and Italy, with the same name, are quite different." (Farlow, *in litt*).

184. PUCCINIA ALETRIDIS B. & C.

Uredo and teleutospores on *Aletris farinosa* L. Kilbourn City, Pammel.

The uredo sori are small; their spores pale yellow, round-ellipoidal, thin walled and sparsely granulated. Their usual size is about 20 μ.

185. PUCCINIA KUHNIAE Schw.

Teleutospores on *Kuhnia eupatorioides* L., in the fall. Madison; La Crosse, Pammel.

186. PUCCINIA PODOPHYLLI Schw. (*P. aculeata* Schw.).

Teleutospores common on *Podophyllum peltatum* L., in June. Madison, Kilbourn City; La Crosse, Pammel.

Sometimes accompanying or preceded by *Aecidium podophylli* Schw., but frequently found where there is no trace of the latter.

187. PUCCINIA XANTHII Schw.

Teleutospores on *Xanthium strumarium* L. and *Ambrosia trifida* L. Madison; La Crosse, Pammel. Also collected ot Hokah, Minn., by Mr. Pammel.

In New England, this is often preceded by an aecidium, according to Dr. Farlow.

188. PUCCINIA FUSCA (Relhan) (*P. anemones* P.).

Teleutospores very abundant, in spring, on *Anemone nemorosa* L. Madison.

The aecidium occurring simultaneously on the same species is *A. punctatum* Pers., and not *A. leucospermum* D C., which is said by European authorities to be a stage of this species. It is frequently associated with *Peronospora pygmaea* Ung. and *Urocystis anemones* (Pers.), but I have never seen it on the same leaf with the brown aecidium.

189. PUCCINIA CONVOLVULI (P.).

Aecidium (*A. dubium* Clinton, *A. calystegiae* Cast., *A. convolvuli* Ces.), uredo and teleutospores on *Convolvulus sepium* L. La-Crosse, Pammel.

190. PUCCINIA GALII (Pers.).

Spermogonia on *Galium aparine* L., in May. Uredo and teleutospores on *G. triflorum* Michx., in summer and fall. Madison; La-Crosse, Pammel.

The teleutospores are uniformly more thickened at the apex, and more clavate in general outline than those of *P. valantiae* Pers., to which the American form has sometimes been referred. The presence of uredospores is also characteristic, and the occurrence of spermogonia indicates that the aecidium will ultimately be found, although I am not aware that it has yet been recorded in this country.

191. PUCCINIA PIMPINELLAE (Strauss) (*P. myrrhis* Schw.).

Aecidium, uredo and teleutospores on *Osmorrhiza brevistylis* D C. Madison; Kirkland, Pammel.

192. PUCCINIA MENTHAE Pers.

Aecidium on *Monarda fistulosa* L. and *Lycopus europaeus* L. Uredo and teleutospores on *Mentha canadensis* L., *Pycnanthemum lanceolatum* Pursh, *Monarda fistulosa* L. and *M. punctata* L. Madison; Sauk City, Lüders; La Crosse, and Hokah, Minn., Pammel.

193. PUCCINIA GENTIANAE (Strauss).

Uredo and teleutospores on *Gentiana andrewsii* Griseb., in autumn. Madison.

194. PUCCINIA FLOSCULOSORUM (A. & S.) (*P. compositarum* Schl., *P. variabilis* Grev., *P. hieracii* Mart.).

Uredo and teleutospores on *Taraxacum dens-leonis* Desf., *Hieracium canadense* Mx., *H. scabrum* Mx., *Cnicus altissimus* Willd., *C. lanceolatus* Hoffm. and *C. discolor* Muhl. Madison; Devil's Lake, Pammel.

Probably several of the aecidia referred to *Aecidium compositarum* Winter belong to this species.

195. PUCCINIA HELIOPSIDIS Schw.

Uredo and teleutospores on *Vernonia fasciculata* Michx. La Crosse, Pammel.

Scarcely distinct.

196. PUCCINIA TANACETI D C.

Uredo and teleutospores on *Artemisia dracunculoides* Pursh. Madison.

197. PUCCINIA HELIANTHI Schw.

Aecidium (*A. helianthi* Schw.) on *Helianthus strumosus* L. Uredo and teleutospores common on *H. grosse-serratus* Mart., *H. annuus* L. and *H. strumosus* L. Madison, Syene; La Crosse, Pammel.

The broader uredospores and the paler apex of the teleutospores distinguish this from the forms of *P. tanaceti*, with which Winter unites it, that I have been able to examine.

198. PUCCINIA VIOLAE (Schum).

Aecidium on *Viola cucullata* Ait., *V. pubescens* Ait. and *V. canadensis* L. Uredo and teleutospores on *V. cucullata* Ait., *V. blanda* Willd. and *V. pubescens* Ait. Madison, Stoughton; Delton, Devil's Lake, Kirkland, Pammel.

199. PUCCINIA RUBIGO VERA (D C.) (*P. straminis* Fckl.).

Uredo and teleutospores common, on *Hordeum jubatum* L.

Aecidium asperifolii Pers., which is said to belong to this species, and which occurs on various Boragineae, has not been found yet.

200. PUCCINIA GRAMINIS Pers.

Aecidium (*Aecidium berberidis* Gmel.) very common in spring, on *Berberis vulgaris* L., wherever the barberry is cultivated. Uredo and teleutospores abounding on many grasses, of which the following have been collected: *Triticum vulgare* Vill., *Avena sativa* L., *Phleum pratense* L., *Hordeum jubatum* L., *Agrostis vulgaris* With., *A. scabra* Willd., *Briza maxima* L., and *Elymus*, sp. Ithaca, Madison, and reported from many other localities.

The uredo appears sparingly in the spring, before aecidia have developed on the barberry, and there is reason for believing that the mycelium hibernates in winter grain and perennial grasses. Although the barberry does not grow wild in the state, it is cultivated in sufficient abundance to stock the state with wheat rust in favorable seasons. The teleutospores are found in fall and winter, and are especially noticeable on the sheaths of grasses, after their death. Attempts made in my laboratory to infect the very young leaves of wheat seedlings with the sporidia from germinating teleutospores have thus far entirely failed, though Plowright claims to

have succeeded. If this were possible it would entirely do away with the necessity for the intervention of the barberry, which, as has been said, is questionable, for other reasons.

201. PUCCINIA CORONATA Cda.

Uredo and teleutospores very common, on *Dactylis glomerata* L., *Avena sativa* L., etc. Madison. The common oat rust in this vicinity is the uredo of this species.

Aecidium rhamni Gmel., which is held to be a state of this species, has not yet been found. It should be looked for on species of *Rhamnus*.

202. PUCCINIA CARICIS (Schum.).

Aecidium (*Aecidium urticae* Schum.) common, in spring, on *Urtica gracilis* Ait. Uredo and teleutospores on *Cyperus schweinitzii* Torr., and other sedges, in fall and winter, common. Madison; La Crosse, Honey Creek, Pammel.

203. PHRAGMIDIUM SUBCORTICIUM (Shrank) (*P. mucronatum* Link).

Uredo and teleutospores on leaves of *Rosa parviflora* Ehrh., and on cultivated roses. Madison.

204. PHRAGMIDIUM SPECIOSUM Fries.

Teleutospores on petioles and stems of *Rosa parviflora* Ehrh., in fall and winter. Madison.

Uredo miniata P., or a form not to be distinguished from it, sometimes occurs on the same plant in spring under suspiciously similar circumstances, but a connection between the two species has not yet been traced.

205. PHRAGMIDIUM RUBI IDAEI (Pers.) (*P. effusum* Fckl., *P. gracile* Grev.).

Uredo and teleutospores on leaves of *Rubus occidentalis* L., in autumn. Madison.

This is the species distributed in Ellis' North American Fungi, No. 282, under the name of *P. incrassatum* Lk., var. *gracile*. The uredo which has been associated with it is very abundant, scattered over the lower surface of the leaves. It may prove to belong to *P. rubi* (Pers.) (*P. bulbosum* Strauss).

206. PHRAGMIDIUM FRAGARIAE (D C.) (*P. triarticulatum*, B. & C., *P. obtusum*, P.).

Uredo (*Uredo potentillarum* D C.) on leaves of *Potentilla canadensis* L. Madison; La Crosse, Pammel.

207. GYMNOSPORANGIUM MACROPUS Link.

Teleutospores common on cultivated *Juniperus virginiana* L., in May. Madison, Syene; Oconomowoc, Lapham; Sauk City, La-Crosse, Pammel.

GYMNOSPORANGIUM SABINAE (Dicks.), var GLOBOSUM Farlow (*G. fuscum*, D C., var. *globosum* Farlow).

Teleutospores on *Juniperus virginiana* L., common on certain trees in May. Madison; River Falls, King.

The galls of this species are less succulent than those of the last, which are commonly known as "Cedar Apples." Cornu records similar galls as caused by it in France (Bull. Soc. Bot. de Fr., v. 25, p. 123).

The common European cluster-cup of the pear (*Roestelia cancellata* Rebent.) is held to be a state of this species, but it does not occur with us, if, indeed, it is found in this country.

209. MELAMPSORA SALICIS CAPREAE (Pers.) (*M. salicina* Lév.).

Uredo and teleutospores common on species of *Salix*, the latter developing after the leaves have fallen. Madison; La Crosse, Pammel.

210. MELAMPSORA POPULINA (Jacq.).

Uredo very common in the fall, on leaves of *Populus monilifera* Ait., *P. tremuloides* Michx., *P. grandidentata* Michx. and *P. balsamifera* L., var. *candicans* Gray. Teleutospores on fading or fallen leaves of the same species. Madison.

211. COLEOSPORIUM SONCHI ARVENSIS (Pers.) (*C. compositarum* Lév., *C. solidaginis* Thuem.).

Uredo and teleutospores common on species of *Solidago* and *Aster*, in summer and fall, Madison; Dells of the Wisconsin, La Crosse, etc., Pammel.

ISOLATED UREDO FORMS.

212. UREDO MINIATA Pers. (*Coleosporium miniatum*, Pers.).

Very common on petioles and stems of *Rosa parviflora* Ehr., in spring. Madison; La Crosse, Pammel.

Precedes *Phragmidium speciosum* Fr., to which some of its forms bear a considerable resemblance in habit.

213. UREDO AGRIMONIAE EUPATORIAE (D C.) (*Coleosporium ochraceum* Bonord.).

Common, on leaves of *Agrimonia eupatoria* L. Madison.

214. UREDO IRIDIS Duby. (*Trichobasis iridicola* Pk!).

On *Iris versicolor* L., in fall. Madison.

215. UREDO PYROLAE (Gmel.).

On *Pyrola elliptica* Nutt., in spring. Madison.

216. UREDO, sp.

On *Mimulus ringens* L., in company with *Aecidium pentstemonis* Schw. La Crosse, Pammel.

Sori small, scattered loosely over both surfaces of the leaf; spores pale orange, very irregular, unevenly warted, 10×23— 15×16μ.

217. UREDO POLYPODII (P.) (*U. filicum* D C., *U. aspidiotus* Pk.?).

On *Cystopteris fragilis* Bernh., in May and June. Madison, Kilbourn City.

Spores obovate to pyriform, smooth, 18—20×23—26μ, usually, 18.5×25μ; thinner walled than European specimens on *Cystopteris* and *Phegopteris*.

218. CAEOMA NITENS Schw. (*C. luminatum* Schw.).

Common in spring, on wild and cultivated plants of *Rubus occidentalis* L. and *R. villosus* Ait. Syene, Stoughton, Madison; Baraboo, La Crosse, Pammel; Janesville, Kellogg.

The common red-rust of raspberries. The orange rust which occurs in autumn is referred to No. 905.

ISOLATED AECIDIAL FORMS.

219. AECIDIUM* FUSTULATUM Curt.

On *Comandra umbellata* Nutt., in spring. Madison; Columbus, Rockwell.

220. AECIDIUM POLEMONII Peck.

On *Phlox pilosa L.* and *Polemonium reptans* L. Common, in spring. Madison.

221. AECIDIUM PODOPHYLLI Schw.

On *Podophyllum peltatum* L., in June. Madison.

Sometimes associated with *Puccinia podophylli* Schw., which, however, more commonly occurs without any trace of the aecidium.

222. AECIDIUM OENOTHERAE Peck.

Very common in spring and summer, on *Oenothera biennis* L. Stoughton, Madison; Baraboo, Pammel; Sauk City, Lüders.

223. AECIDIUM LYSIMACHIAE Lk.

On *Steironema lanceolata* Raf. (?) La Crosse, Pammel.

224. AECIDIUM SOLANI Mont.

On *Physalis virginica* Mill. and *P. lanceolata* Michx. Sauk City, Lüders.

---

* This name is sometimes written *Oecidium*. See Malinvaud, Bull. Soc. Bot. France, 1880, No. 5.

225. AECIDIUM PETERSII B. & C.

On *Viola delphinifolia* Nutt. Common, in spring. Madison. Peridia longer than those of the aecidium of *Puccinia violae.*

226. AECIDIUM GERANII D C.

Very common, in spring, on leaves of *Geranium maculatum* L.

227. AECIDIUM GROSSULARIAE D C.

On leaves, pedicels and flowers of *Ribes rotundifolium* Mx., *R. floridum* L'Her., *R. cynosbati* L., *R. aureum* Pursh and *R. rubrum* L. Everywhere, in spring. Madison; La Crosse, Pammel.

This cannot be distinguished from the European species, which is called by Winter the aecidium of *Puccinia grossulariae* Gmel., with which he identifies the American *P. pulchella* Pk. Though the aecidium is one of the commonest of fungi everywhere east of the Mississippi, I am not aware that its assumed teleutosporic form has been recorded for any locality but the one given by Peck. Dr. Magnus, also, writing of this species as it occurs in Germany, says "*Aecidium grossulariae* certainly is an isolated aecidium, which belongs to a heteroecismal *Puccinia*, as I convinced myself some years since by observations on *Ribes nigrum, R. grossularia* and *R. alpinum*, in the vicinity of Berlin." *

Since the above was written, Plowright, discussing British Uredineae, says: "As no *Puccinia* occurs on gooseberry leaves in this country, it is clear *Aecidium grossulariae*, as we find it, is not a Pucciniopsis but is probably a heteroecismal species." (Grevillea, XII., 36). the same conclusion is reached in Denmark, by Rostrup (Rev. Mycolgique, October 1884, p. 211).

228. AECIDIUM POLYGALINUM Peck.

On *Polygala senega* L. Madison; La Crosse, Pammel.

229. AECIDIUM IMPATIENTATUM Schw.

On *Impatiens fulva* Nutt. and *I. pallida* Nutt. Madison; La Crosse, Pammel; Sauk City, Lüders. Also collected at Hokah, Minn., by Mr. Pammel.

230. AECIDIUM JAMESIANUM Peck.

On *Asclepias tuberosa* L., *A. cornuti* Dec., *A. ovalifolia* Dec. and *Acerates longifolia* Ell. Stoughton; La Crosse, Pammel; Sauk City, Lüders.

This is called the aecidium of *Uromyces howei* (Peck) by Mr. Arthur (Bull. Minn. Acad., XI., 25).

The bright orange-red spores contrast beautifully with the pure white peridia, much as in *Roestelia aurantiaca* Pk., and the thickening of their walls, mentioned by Mr. Arthur, is very characteristic.

---

* (Verhandl. Bot. Verein, Prov. Brandenburg, v. 23, p. XXVII-XXVIII.)

160. UROMYCES ACUMINATUS Arthur.

Uredo and teleutospores on *Spartina cynosuroides* Willd. Madison; La Crosse, Pammel.

A very variable species, which in some of its forms can scarcely be distinguished from a species on several grasses from other parts of the country, which may be a form of the variable *U. dactylidis* Otth.

161. PUCCINIA CIRCAEAE Pers.

Teleutospores very abundant on leaves of *Circaea lutetiana* L. Madison; La Crosse, Pammel; also collected at Hokah, Minn., by Mr. Pammel.

162. PUCCINIA ANEMONES VIRGINIANAE Schw. (*P. solida* Schw.).

Teleutospores on *Anemone virginiana* L. and *A. cylindrica* Gray, in August. Madison; La Crosse, and Hokah, Minn., Pammel.

163. PUCCINIA THALICTRI Chevall.

Teleutospores on *Thalictrum dioicum* L. and *T. cornuti* L. Madison; Kirkland, La Crosse, Pammel.

I do not see how this can be distinguished morphologically from *P. anemones* Pers. It is usually marked with larger and more obtuse warts than our specimens of the latter, but European specimens of *P. anemones* sometimes have quite as coarse granulations as our *P. thalictri*.

164. PUCCINIA HYDROPHYLLI Peck & Clinton.

Teleutospores on *Hydrophyllum virginicum* L. Madison.

165. PUCCINIA LOBELIAE Ger. (*P. microsperma* B. & C.).

Teleutospores on *Lobelia syphilitica* L., in August. Madison.

166. PUCCINIA VERRUCOSA (Schultz). (*P. hyssopi* Schw.).

Teleutospores on *Lophanthus scrophulariaefolius* Benth. La Crosse, Pammel.

167. PUCCINIA SILPHII Schw.

Teleutospores on *Silphium perfoliatum* L. and *S. integrifolium* Mich. Stoughton; La Crosse, Pammel.

On the latter host sometimes accompanied by the spermogonia of an aecidium, in June. (*cf.* No. 242.)

168. PUCCINIA ASTERIS Duby. (*P. asteris* Schw.).

Teleutospores on *Aster corymbosus* Ait., *A. cordifolius* L. and *A. tradescanti* L. La Crosse, Dells of the Wisconsin, Pammel.

169. PUCCINIA SOLIDAGINIS Pk.

On leaves of *Solidago nemoralis* Ait. (?) La Crosse, Pammel.

Paler than the type, which it otherwise resembles, according to Professor Peck.

The teleutospores are often forked; in some cases the division extends merely through the terminal papilla; in others the lower cell is produced into a thickened papilla just below the septum.

170. PUCCINIA TOMIPARA, n. sp.

Uredo and teleutospores on a species of *Bromus*, apparently *B. ciliatus* L. La Crosse, Pammel.

II. Sori small, round, or little elongated, on the upper surface of the leaf. Spores commonly round, somewhat roughened with blunt, inconspicuous warts; pale yellow, 22–26 μ.

III. Sori compact, black, long covered by the epidermis; round or slightly elongated, usually about .2 mm. in diameter. Spores pale chestnut-brown, thin walled, without apical thickening; irregularly oblong, sessile: 2–5-celled, often tomiparous: 13–22×35–43 μ.

The species is remarkable from the fact that the spores are commonly 3–4-celled, with the uppermost septum oblique or not infrequently parallel to the axis of the spore, which is thus made to consist of more than one row of cells. It somewhat resembles *P. triarticulata* B. & C., which occurs on *Elymus*, and which has 3-celled spores; but these are longer and differently shaped.

171. PUCCINIA BARYI (B. & Br.) (*P. striatula* Thuem., *P. linearis* Pk.).

Uredo and teleutospores on some dead grass, possibly *Andropogon scoparius* Michx. Madison.

Well marked by the strongly clubbed paraphyses.

172. PUCCINIA ANDROPOGI Schw. (*P. ellisiana* Thuem.).

Teleutospores on *Andropogon scoparius* Mx. Madison; Milwaukee, Lapham; La Crosse, Pammel.

This has been compared with Schweinitzian specimens, by Dr. Farlow. The teleutospores are not unlike those of *P. cesati* Schr., as described by Winter.

173. PUCCINIA ARUNDINARIAE Schw.

Teleutospores on dead leaves of *Spartina cynosuroides* Willd., in winter and spring. Madison.

174. PUCCINIA EMACULATA Schw. (*P. graminis* P., var. *brevicarpa* Peck).

Teleutospores on *Panicum capillare* L. Madison; La Crosse, Pammel.

175. PUCCINIA VEXANS Farlow.

The form described by Peck as *Uromyces brandegeei*, but now held to be the uredo or mesosporic form of this species, was found once on *Bouteloua racemosa* Lag., at La Crosse, by Mr. Pammel. The quantity examined was small, and no teleutospores were seen.

160. UROMYCES ACUMINATUS Arthur.

Uredo and teleutospores on *Spartina cynosuroides* Willd. Madison; La Crosse, Pammel.

A very variable species, which in some of its forms can scarcely be distinguished from a species on several grasses from other parts of the country, which may be a form of the variable *U. dactylidis* Otth.

161. PUCCINIA CIRCAEAE Pers.

Teleutospores very abundant on leaves of *Circaea lutetiana* L. Madison; La Crosse, Pammel; also collected at Hokah, Minn., by Mr. Pammel.

162. PUCCINIA ANEMONES VIRGINIANAE Schw. (*P. solida* Schw.).

Teleutospores on *Anemone virginiana* L. and *A. cylindrica* Gray, in August. Madison; La Crosse, and Hokah, Minn., Pammel.

163. PUCCINIA THALICTRI Chevall.

Teleutospores on *Thalictrum dioicum* L. and *T. cornuti* L. Madison; Kirkland, La Crosse, Pammel.

I do not see how this can be distinguished morphologically from *P. anemones* Pers. It is usually marked with larger and more obtuse warts than our specimens of the latter, but European specimens of *P. anemones* sometimes have quite as coarse granulations as our *P. thalictri*.

164. PUCCINIA HYDROPHYLLI Peck & Clinton.

Teleutospores on *Hydrophyllum virginicum* L. Madison.

165. PUCCINIA LOBELIAE Ger. (*P. microsperma* B. & C.).

Teleutospores on *Lobelia syphilitica* L., in August. Madison.

166. PUCCINIA VERRUCOSA (Schultz). (*P. hyssopi* Schw.).

Teleutospores on *Lophanthus scrophulariaefolius* Benth. La Crosse, Pammel.

167. PUCCINIA SILPHII Schw.

Teleutospores on *Silphium perfoliatum* L. and *S. integrifolium* Mich. Stoughton; La Crosse, Pammel.

On the latter host sometimes accompanied by the spermogonia of an aecidium, in June. (*cf.* No. 242.)

168. PUCCINIA ASTERIS Duby. (*P. asteris* Schw.).

Teleutospores on *Aster corymbosus* Ait., *A. cordifolius* L. and *A. tradescanti* L. La Crosse, Dells of the Wisconsin, Pammel.

169. PUCCINIA SOLIDAGINIS Pk.

On leaves of *Solidago nemoralis* Ait. (?) La Crosse, Pammel.

Paler than the type, which it otherwise resembles, according to Professor Peck.

The teleutospores are often forked; in some cases the division extends merely through the terminal papilla; in others the lower cell is produced into a thickened papilla just below the septum.

170. PUCCINIA TOMIPARA, n. sp.

Uredo and teleutospores on a species of *Bromus*, apparently *B. ciliatus* L. La Crosse, Pammel.

II. Sori small, round, or little elongated, on the upper surface of the leaf. Spores commonly round, somewhat roughened with blunt, inconspicuous warts; pale yellow, 22–26 μ.

III. Sori compact, black, long covered by the epidermis; round or slightly elongated, usually about .2 mm. in diameter. Spores pale chestnut-brown, thin walled, without apical thickening; irregularly oblong, sessile: 2–5-celled, often tomiparous: 13–22×35–43 μ.

The species is remarkable from the fact that the spores are commonly 3–4-celled, with the uppermost septum oblique or not infrequently parallel to the axis of the spore, which is thus made to consist of more than one row of cells. It somewhat resembles *P. triarticulata* B. & C., which occurs on *Elymus*, and which has 3-celled spores; but these are longer and differently shaped.

171. PUCCINIA BARYI (B. & Br.) (*P. striatula* Thuem., *P. linearis* Pk.).

Uredo and teleutospores on some dead grass, possibly *Andropogon scoparius* Michx. Madison.

Well marked by the strongly clubbed paraphyses.

172. PUCCINIA ANDROPOGI Schw. (*P. ellisiana* Thuem.).

Teleutospores on *Andropogon scoparius* Mx. Madison; Milwaukee, Lapham; La Crosse, Pammel.

This has been compared with Schweinitzian specimens, by Dr. Farlow. The teleutospores are not unlike those of *P. cesati* Schr., as described by Winter.

173. PUCCINIA ARUNDINARIAE Schw.

Teleutospores on dead leaves of *Spartina cynosuroides* Willd., in winter and spring. Madison.

174. PUCCINIA EMACULATA Schw. (*P. graminis* P., var. *brevicarpa* Peck).

Teleutospores on *Panicum capillare* L. Madison; La Crosse, Pammel.

175. PUCCINIA VEXANS Farlow.

The form described by Peck as *Uromyces brandegeei*, but now held to be the uredo or mesosporic form of this species, was found once on *Bouteloua racemosa* Lag., at La Crosse, by Mr. Pammel. The quantity examined was small, and no teleutospores were seen.

260. ENTYLOMA BESSEYI Farlow (*E. physalidis* Wint., *Protomyces physalidis* K. & C.?).

On *Physalis*, sp. Madison; La Crosse, Pammel.

The description does not allow it to be distinguished from the African species described by Kalchbrenner and Cooke (Grevilles, IX., 22).

261. ENTYLOMA MICROSPORUM (Ung.).

On leaf and petiole of *Ranunculus fascicularis* Muhl. Stoughton.

262. ENTYLOMA MENISPERMI Farlow and Trelease.

In leaves of *Menispermum canadense* L. Madison; Hokah, Minn., Pammel.

263. ENTYLOMA THALICTRI Schroeter (?).

In leaves of *Thalictrum dioicum* L. Common in the fall. Madison.

This seems to be distinct from *E. ranunculi* (Bonord.), to which it was doubtfully referred by Farlow (Botanical Gazette, August, 1883). Having seen no description of Schroeter's species, however, I can only assume that the two may be identical.

264. DOASSANSIA ALISMATIS (Fr.).

In leaves of *Alisma plantago* L., var. *americana* Gray, and *Sagittaria variabilis* Engelm. Madison.

The young spots in spring are white, and look like those of an *Entyloma*. The conidia on *Sagittaria* are hyaline, cylindrical or fusiform, 1-celled, and measure 2–3×12–20 μ.

265. UROCYSTIS ANEMONES (Pers.) (*U. pompholygodes* Schl.).

In stems and leaves of *Anemone nemorosa* L. and *A. dichotoma* L. Madison; La Crosse, Pammel.

266. UROCYSTIS OCCULTA (Wall.).

In leaves of *Elymus canadensis* L. Stoughton.

267. ENTOMOPHTHORA MUSCAE (Cohn).

Very common, on house flies, in fall. Madison, Syene.

The common fall disease of flies. The tarichium state of *E. calopteni* Busey will probably be found here in the larger grasshopper (*Caloptenus differentialis*).

THELEPHOREAE.

268. EXOBASIDIUM VACCINII Wor.

On *Gaylussacia resinosa* Torr. & Gray and *Vaccinium*, sp. Kirkland, La Crosse, Pammel. Also collected on the last-named host at Hokah, Minn., by Mr. Pammel.

Undoubtedly occurs on the cranberry and other Ericaceae here as elsewhere.

ALPHABETICAL INDEX TO HOSTS.*

A.

Acer dasycarpum, 135.
rubrum, 34.
Acerates longifolia, 230.
Acorus calamus, 156.
Aesculus hippocastanum, 111.
Agaric, 58.
Agrimonia eupatoria, 45, 213.
Agrostis scabra, 67, 200.
vulgaris, 200.
Aletris farinosa, 184.
Alisma plantago, 264.
Allium cepa, 27.
tricoccum, 127.
Amarantus retroflexus, 6.
Amber cane, 247.
Ambrosia artemisiaefolia, 5, 10, 48, 256.
psilostachya, 256.
trifida, 10, 187.
Amelanchier canadensis, 244.
Amianthium, 188.
Amorpha canescens, 181.
fruticosa, 181.
Ampelopsis quinquefolia, 9, 32, 112.
Amphicarpaea monoica, 1, 49, 149.
Andropogon furcatus, 64.
scoparius, 171, 172.
Anemone acutiloba, 237.
cylindrica, 162.
dichotoma, 78, 234, 265.
nemorosa, 2, 14, 188, 237, 265.
virginiana, 162.
Apocynum cannabinum, 92, 115.
Apple, 101, 116.
Aquilegia canadensis, 137.
Archangelica atropurpurea, 100.
Arisaema triphyllum, 157.
Artemisia, 24*a*.
biennis, 5.
dracunculoides, 196.
Artichoke, Jerusalem, 10.
Asclepias cornuti, 230.
ovalifolia, 230.
tuberosa, 230.
Ash, 233.
Aspidium marginale, 90.
Asprella hystrix, 55.
Aster, 56, 73, 146, 211, 242.
cordifolius, 168.
corymbosus, 168.
laevis, 48.
miser, 48.
novae angliae, 13, 83.
puniceus, 256.
sericeus, 242.
tradescanti, 168.
umbellatus, 48.
vimineus, 168.
Astragalus, 89.
Avena sativa, 200, 201, 249.

B.

Barberry, 200.
Barley, 249.
Beans, 19, 107, 149.
Beet, 94.
Berberis vulgaris, 200.
Beta vulgaris, 94.
Bidens frondosa, 10, 45.
Bittersweet, 79.
Blackberry, 141, 218.
Black walnut, 109.
Blueberry, 268.
Blue grass, 50.
Boletus, 104.
Bouteloua racemosa, 175.
Brassica, 16.
Briza mazima, 200.
Bromus, 146.
ciliatus, 170.
Brunella vulgaris, 45.
Butternut, 77, 109.

C.

Calamagrostis canadensis, 67.
Calystegia sepium, 142, 189.
Cane, Amber, 247.
Cannabis sativa, 134.
Capsella bursa pastoris, 4, 16.
Carpinus americana, 44, 59.
Castilleia sessiliflora, 240.
Cedar, Red, 207, 208.
Celastrus scandens, 44, 79.
Cenchrus tribuloides, 253.
Chenopodium album, 20, 95.
Cherry, 43.
Circaea lutetiana, 161.
Cirsium altissimum, 194.
discolor, 194.
lanceolatum, 5, 194.
Clematis virginiana, 47.
Clover, 53, 71, 152.
Clover, Sweet, 108.
Cnicus altissimus, 194.
discolor, 194.
lanceolatus, 5, 194.
Comandra umbellata, 219.
Convolvulus sepium, 142, 189.
Coptis trifolia, 138.
Corn, Indian, 177, 248.
Cornus, 44.
Corylus americana, 40, 44, 60, 63.
rostrata, 40, 60.
Cottonwood, 210.
Crab apple, 101.
Cranberry, 268.
Crataegus coccinea, 243.
tomentosa, 243.
Currant, 128, 227.
Cynoglossum morisoni, 48.
Cynthia virginica, 242.
Cyperus schweinitzii, 202.
Cystopteris fragilis, 217.

D.

Dactylis glomerata, 55, 201.
Dentaria laciniata, 126.
Desmodium, 89, 155.
acuminatum, 57, 150.
canescens, 37.
Deyeuxia canadensis, 67.
Dicentra cucullaria, 24, 238.
Diplopappus umbellatus, 48.
Dock, 86.
Dodecatheon meadia, 113.

* The fungi are referred to by their list numbers.

E.

Echinospermum virginicum, 48.
Elder, 30, 232.
Elm, 53.
Elodes virginica, 158.
Elymus, 64, 170, 200.
canadensis, 55, 67, 255, 266.
striatus, 67.
Eragrostis poaeoides, 251.
Erigeron, 130.
annuum, 242.
canadense, 242.
strigosum, 242.
Euchlaena luxurians, 248.
Eupatorium ageratoides, 10, 69.
perfoliatum, 48, 242.
purpureum, 48.
Euphorbia corollata, 35, 239.
hypericifolia, 152*a*.
maculata, 152*a*.

F.

Fish, 3.
Flies, 3, 267.
Fragaria vesca, 81.
virginiana, 81.
Fraxinus samoucifolia, 233.

G.

Galium aparine, 190.
boreale, 22.
triflorum, 22, 190.
Gaylussacia resinosa, 268.
Gentiana andrewsii, 193.
Geranium maculatum, 12, 226.
Glyceria nervata, 67.
Gooseberry, 128, 227.
Grape, 9, 33, 110, 112, 121*a*.
Grasses: 28, 50, 55, 64–67, 102, 122, 140, 146, 160, 170–177, 199, 200, 201, 246–253, 255, 258, 266.
Grubs, White, 68.
Gymnostichum hystrix, 55.

H.

Hazel, 40, 60, 63.
Helianthus, 56.
annuus, 197.
grosse serratus, 197.
occidentalis, 10.
strumosus, 10, 48, 197.
tuberosus, 10.
Hemp, 134.
Hepatica acutiloba, 237.
Hieracium canadense, 194.
scabrum, 194.
Hordeum jubatum, 199, 200.
vulgare, 249.
Horse chestnut, 111.
Horseradish, 16, 84.
Huckleberry, 268.
Hydrophyllum virginicum, 48, 164.
Hypericum pyramidatum, 158.

I.

Ilex laevigata, 74.
verticillata, 74.
Impatiens fulva, 11, 125, 180, 229
pallida, 11, 180, 229.
Indian corn, 177, 248.
Iris versicolor, 146, 214.
Iron wood, 44, 50.
Ivy, Poison, 147.

J.

Jerusalem artichoke, 10.
Juglans cinerea, 77, 109.
nigra, 108.
Juncus, 146, 154, 252.
Juniper, 243.
Juniperus communis, 243.
virginiana, 207, 208.

K.

Koeleria cristata, 67.
Krigia amplexicaulis, 242.
Kuhnia eupatorioides, 185.

L.

Lactuca canadensis, 15, 242.
sativa, 15.
Lathyrus, 149.
ochroleucus, 37.
palustris, 150.
venosus, 49, 150.
Lepachys pinnata, 256.
Lepidium virginicum, 16.
Lespedeza capitata, 51, 151.
violacea, 37.
Lettuce, 15.
Lilac, 36.
Lilium canadense, 153.
Lobelia inflata, 257.
syphilitica, 165.
Locust, 62.
Lonicera flava, 38.
glauca, 38.
parviflora, 38.
Lopnanthus scrophulariaefolius, 26, 168.
Lycopus europaeus, 192.
Lysimachia lanceolata, 223.

M.

Malva rotundifolia, 133.
Maple, 34, 135.
Melilotus albus, 108.
Menispermum canadense, 262.
Mentha canadensis, 192.
Mimulus ringens, 216, 240.
Monarda fistulosa, 192.
punctata, 192.

N.

Nabalus, 45, 242.
Nasturtium armoracia, 16, 84.
Nettle, 85, 202.

O.

Oak, 30, 41, 114, 121.
Oats, 200, 201, 249.
Oenothera biennis, 18, 131, 222.
Onion, 27.
Orchard grass, 55, 201.
Osmorrhiza brevistylis, 191.
Oxalis stricta, 42.
Oxybaphus nyctagineus, 119.

P.

Panicum capillare, 174.
latifolium, 55.
sanguinale, 102, 250.
Parsnep, 93.
Pastinaca sativa, 93.
Pear, 208.
Pentstemon pubescens, 240.
Petalostemon, 182.

Phaseolus, 107, 149.
Phleum pratense, 67, 200, 255.
Phlox divaricata, 139.
drummondii, 48.
paniculata, 48.
pilosa, 220.
Phragmidium, 146.
Phragmites communis, 176.
Physalis, 97, 260.
lanceolata, 224.
virginica, 224.
Plantago major, 21, 80.
Plowrightia morbosa, 106.
Plum, 29, 43, 61, 106, 179.
Poa annua, 140.
compressa, 67.
pratensis, 50.
Podophyllum peltatum, 69, 186, 221.
Poison ivy, 147.
Polemonium reptans, 220.
Polygala senega, 228.
Polygonatum biflorum, 231.
giganteum, 231.
Polygonum amphibium, 146, 178.
aviculare, 148.
erectum, 148.
hydropiper, 145.
Populus alba, 109a.
balsamifera, 31, 210.
grandidentata, 210.
monilifera, 210.
tremuloides, 210.
Portulaca oleracea, 7.
Potato, 8.
Potentilla canadensis, 146, 206.
norvegica, 17, 75, 82.
Prenanthes, 45, 242.
Prunus, 29.
americana, 61, 106, 179.
pennsylvanica, 61.
serotina, 61, 117, 124.
virginiana, 43, 61, 179.
Pteris aquilina, 52.
Puccinia, 146.
Puff-ball, 103.
Purslane, 7.
Pycnanthemum lanceolatum, 146, 192.
Pyrola elliptica, 215.
rotundifolia, 88.
Pyrus arbutifolia, 98, 245.
communis, 208.
coronaria, 101, 244.
malus, 101, 116.
prunifolia, 101.

Q.

Quercus, 121.
alba, 114.
coccinea, 30.
macrocarpa, 114.
rubra, 30, 41.

R.

Ranunculus abortivus, 49, 236.
fascicularis, 78, 261.
pennsylvanicus, 70.
recurvatus, 78.
sceleratus, 70.
Raspberry, 205, 218.
Reana luxurians, 248.
Red cedar, 207, 208.
Red-top, 200.
Rhamnus, 201.
Rhus toxicodendron, 147.
Ribes, 144.
aureum, 227.
cynosbati, 128, 227.
floridum, 128, 227.
rotundifolium, 227.
rubrum, 227.
Robinia pseudacacia, 62.
Roses, 44, 203.
Rosa parviflora, 46, 203, 204, 212.
Rubus occidentalis, 205, 218.
strigosus, 141.
villosus, 218.
Rudbeckia laciniata, 10, 159.
Rumex, 86.
Rye, 65.

S.

Sagittaria variabilis, 264.
Salix, 31, 72, 105, 209.
Sambucus canadensis 39, 232.
Scrophularia nodosa, 132.
Secale cereale, 65
Setaria glauca, 246.
italica, 28.
viridis, 28, 140.
Sicyos angulatus, 25.
Silphium integrifolium, 10, 118, 143, 167, 256.
perfoliatum, 10, 167, 242.
terebinthinaceum, 10.
trifoliatum, 10.
Silver maple, 135.
Sisymbrium officinale, 4.
Sium lineare, 241.
Smilacina racemosa, 231.
Solanum tuberosum, 8.
Solidago, 13, 73, 91, 211, 242.
nemoralis, 169.
riddellii, 10, 242.
Sorghum saccharatum, 247.
Spartina cynosuroides, 122, 146, 160, 173.
Sphaeria morbosa, 106.
Spiders, 69, 76.
Spiraea salicifolia, 128.
Staphylea trifolia, 87.
Steironema lanceolata, 223.
Strawberry, 81.
Sunflower, 197.
Sweet clover, 108.
Syringa vulgaris, 36.

T.

Taraxacum dens leonis, 45, 194, 242.
officinale, 45, 194, 242.
Teosinte, 248.
Teucrium canadense, 48, 96.
Thalictrum cornuti, 163.
dioicum, 49, 163, 235, 263.
Thistles, 5, 194.
Timothy, 67, 200, 255.
Toadstools, 58.
Trifolium incarnatum, 152.
pratense, 54, 71.
repens, 54, 152.
Triosteum perfoliatum, 99a.
Triticum vulgare, 65, 200, 249, 254.

U.

Ulmus americana, 53.
Uredineae, 146.
Uredo, 146.
Uromyces, 146.
Urtica gracilis, 85, 202.

V.

Vaccinium, 268.
Verbena urticifolia, 42.
Vernonia fasciculata, 195.
noveboracensis, 118, 242.
Veronica peregrina, 259.
virginica, 45.
Vicia americana, 19, 136.
faba, 19.

Viola blanda, 198.
canadensis, 198.
culcullata, 99, 198.
delphinifolia, 285.
pubescens, 130, 199, 198.
Vitis, 9, 33, 110, 112, 121*a*.

W.

Walnut, Black, 109.
Wax beans, 107.
Wheat, 65, 200, 249, 254.
White grubs, 68.
Willow, 31, 72, 105, 209.

X.

Xanthium strumarium, 48, 187.

Z.

Zea mays, 177, 248.
Zizania aquatica, 66, 268.
Zizia integerrima, 100.
Zygadenus glaucus, 188.

ON THE PRESENT STATE OF OUR KNOWLEDGE OF STELLAR MOTION.

By TRUMAN HENRY SAFFORD, Ph. D., Field Memorial Professor of Astronomy in Williams College.

The stellar motions, the so-called proper motions of the stars, which used to be thought fixed, seem to us very small, because the suns we call stars are so very far away.

Bodies which move at least as rapidly as our earth does about its sun, seem to move with velocities rarely exceeding one second a year; and this large stellar motion is only sufficient to produce a displacement equal to the moon's diameter as we see it in about eighteen centuries.

Under these circumstances another cause besides the apparent slowness makes the problem in question a troublesome one — the fact, namely, that accurate astronomical observation is a thing of less than two centuries past — and even Flamsteed, who commenced it, is now antiquated — and we are obliged to take Bradley's later observations — from 1750 on — as the real beginning.

Moreover, as years go by, it is found possible and necessary to re-reduce the older star-catalogues, in order to make use of the past records to the greatest possible extent.

Thus Bessel's Bradley's catalogue superseded in 1818 Bradley's own catalogue; and Professor Auwers has already published the chief results of a new reduction, which, using Bessel's principles and methods, supersedes Bessel's results.

Another element of difficulty in the problem lies in the comparative ease of making new observations upon the stars in a routine way, and the greater difficulty of selecting the fittest objects and observing those only. The practical astronomer who has learned simply how to observe, is far inferior to him, whose ability lies in a combination of the power to select well his working list, that to observe to the last degree of accuracy, and that to discuss results with skill and completeness. And the German school of astronomers, established by Bessel, Gauss and Struve, is at the

same time the most perfect and the most regardful of all these matters.

At present star-catalogues are many; but complete discussions of their results are very scanty in comparison.

Three elements must then be considered in the present paper.

First, what old catalogues need re-reduction?

Second, what new observations need to be added to those now in progress.

Third, what discussions of stellar motion by the help of these materials are timely and needful.

Bradley's observations, as I have said before, have been re-reduced by Auwers; and his work is partly published; he has also taken care that new observations be made upon such of the stars as needed them; the resulting new catalogue by Dr. Becker of the Berlin observatory has been published, with proper motions discussed by Auwers; and Bradley's stars need not be observed any more for the present, except for purposes of the most refined accuracy. It will be an economy in by far the most cases simply to drop all Bradley stars from our working lists.

Flamsteed and Lacaille, from their want of precision, need hardly be considered in this connection; Lacaille's observations were, it is true, partly of some accuracy for his time; but *these* cases will mostly come up under other circumstances, as repetitions of Bradley; or else will be included in the Cape of Good Hope observations. Lacaille's far southern stars, whether well or ill observed by himself, are all continued in the new Cape catalogue.

T. Mayer (1756) observed zodiacal stars mainly. These are now in process of reobservation at Berlin.

Prof. Newcomb has lately prepared a catalogue of standard and zodiacal stars; so that the observer or computer who wishes to economize his labor had best avoid all stars within 6 degrees of the ecliptic; especially as the Greenwich observatory, and also that at Wilhelmshaven, so far as its means allow, are especially careful about stars near the moon's path from year to year.

The Lalande zones, including Fedorenko and D'Agelet,

have been or are to be reobserved in the great zones now going on under the auspices of the Astronomische Gesellschaft, an international association having its seat at Leipzig. This reobservation is certainly sufficiently accurate to compare with Lalande, whose single observations were made with less accurate instruments than would now be employed; and whose mistakes are many. His zones have been fairly well reduced; and the lamented von Asten has computed new tables of reduction for most of them.

Piazzi's Palermo catalogue of 7,646 stars for 1800 needs a new reduction. This would, however, be an enormous labor; there are nearly 100,000 observations. Ten years' labor of a skillful computer would at least be needed; and probably this is a very low estimate. The stars do not now need reobservation owing to the great zones just mentioned.

Groombridge's catalogue for 1810 of 4,243 stars needs also a revision. But this would be much easier, as the original manuscript calculations are preserved; and are probably very free from mistakes. What is chiefly needed here is a careful study of the azimuth correction of Groombridge's meridian circle.

William von Struve published a catalogue of right ascensions for 1814 and 1815 in the first volume of the Dorpat observations. This, probably, needs some little revision, owing to its early date; and the same eminent observer continued this work during 1818 and 1819; but these latter observations are unreduced.

Years' work might readily be spent upon these right ascensions of Struve; and would be important for the revision of Groombridge, as the latter would be for that of Piazzi.

I have myself in progress a careful reobservation of the stars observed by Struve, especially for the difficult region within 10° of the north pole.

From the Greenwich observations of Bliss and Maskelyne, not much can be obtained for the stars' places. The planets, sun and moon, were the main subjects of Maskelyne's attention. S. Hertzsprung has reduced some of Maskelyne's work upon small stars, and I am myself calculating some more of it for another purpose.

But Pond, who was Astronomer Royal from 1811 to 1835, has left vast folios of observations; a good many of them need a new reduction and discussion. It may, perhaps, be hoped that the Greenwich authorities will accomplish this work at some future period; it is probably not immediately pressing.

Bessel, at Königsberg, accumulated a great store of observations. Among them is the material for a considerable catalogue of zodiacal stars, which a year's work would perhaps complete ready for press. It is all indexed and its mean epoch would be 1830 or 1835. The stars contained in it are also mostly in Piazzi and Mayer; but Bessel's observations are so much better than these as to make up for their comparative newness.

Something can also be made out of the same great astronomer's work between 1814 and 1819 although, his instruments were then very inferior to those employed later.

Another very useful, though very scattered, collection of older star-places, mainly declinations, could be made up by a careful study of the early latitude work of various astronomers from Mudge and Lambson, down to Bessel, Gauss and Struve.

Struve's great Dorpat catalogue, published in 1852, but containing results of observations back to 1822, has been, I believe, completely reobserved at Pulkova. So far as the other catalogues for epochs about 1830 are concerned, I fancy few of them need much reobservation; as they largely contain identical stars.

A few stars in the Abo catalogue (Argelander's of 1830) need reobservation as well as rediscussion. My own copy of this catalogue once belonged to the lamented Tiele, an assistant at Bonn; and contains manuscript notes of results—apparently calculated under Argelander's direction, which are nowhere else published as far as I know. The doubtful stars are in all cases such as were imperfectly observed before Argelander, and so mentioned in his notes.

There is a class of several hundred stars which, although visible to the naked eye, were only found in Lalande's and Bessel's zones when Argelander placed them in the Urano-

metria Nova. These were soon after observed by Henderson at Edinburgh, and by the Pulkova astronomers. They are much needed for field work in latitude and longitude. I have myself often missed accurate modern places for them, and hope to see them soon catalogued. The Edinburgh catalogue of Henderson is excellent in general plan, but is yet unfinished. The astronomer who shall put it together from the yearly volumes of 1834 to 1844 inclusive, will accomplish a considerable service at comparatively trifling cost. And these places begin to be old enough to serve as an old catalogue. The great Pulkova work of the same character is vigorously in progress, and will be soon completed.

The old catalogues, then, which need re-reduction or compilation, are these, with their epochs:

Piazzi, much the largest of all	1800
Mayer	1756
Groombridge (revision)	1810
Struve, circumpolar	1815
Pond (revision and recalculation)	1830
Bessel, zodiacal	1830
Miscellaneous latitude stars	1785–1830
Edinburgh (compilation)	1840

Of new star catalogues to be made I think the most important, next to the great zones several times mentioned, which are now nearly done for the northern hemisphere, is an accurate reobservation of all stars to the seventh magnitude inclusive, which are not now well known.

For the region south of the celestial equator there need be little solicitude in this matter, as the powerful observatories of the Cape, Melbourne and Cordoba have probably so nearly filled the gaps left at northern stations, that we can afford to wait till the results to date are completely published for the two latter ones. And the extension to the Tropic of Capricorn of the northern zones will show what farther is acking.

North of the equator, the stars of the first four magnitudes are nearly all Pulkova fundamentals, and thus well known, even where occasionally neglected at other places. Those of the fifth and sixth magnitudes have either been, or

are about to be, carefully observed at Greenwich; our Coast Survey has requested a few specially neglected ones of these degrees of brightness to be attended to at three or four places.

It may then be said that those astronomers who wish to contribute to our knowledge of bright stars' places, have only to supply such observations as they themselves use for semi-fundamental purposes, and observe stars of the *seventh* magnitude; and a few brighter which may have been neglected.

I have not yet mentioned the British Association Catalogue. This was published in 1852; its places and proper motions were then inaccurate, and are now relatively much worse, as great improvements have since been made in precision of observation. But the stars of this catalogue have been greatly preferred in observatories, owing to its great convenience as a working list; so that the general result now is, that an astronomer who wishes to do anything not superfluous, or liable soon to become so, must be very wary in his work upon these stars.

I have myself long kept an index of them, showing where and when their positions have been lately determined; and have thus saved myself much labor. The index is not quite complete, even for the northern hemisphere; a considerable portion of it is virtually published in my catalogue of 2,018 stars (Washington, War Department, 1879), and my manuscripts of the remainder are in such condition that I can readily give authorities for any B. A. C. star north of the equator.

When the great zones are published (this is to be expected to take place in portions for the next ten years), they will contain comparisons with several old authorities, and will thus indicate many new stars whose proper motions are to be looked for. They will consequently be referred to for this purpose by every one interested in this subject.

Of least square discussions of this subject, published in full, we have principally Mädler's Bradley, vols. 14 and 16 of the Dorpat observations, and volume 7 of the Bonn observations, which contains two long memoirs by Argelander.

Mädler's Bradley is in the main superseded by Auwers' but is often convenient to refer to as an index and approximate check for such stars as were defectively or poorly observed by Bradley.

Argelander's papers are indispensable to any one who wishes to master the subject; they have been excelled in small details, hardly in general plan. The miscellaneous list of considerable proper motions which the great astronomer here gives deserves occasional reobservation, as many of the stars were poorly observed before him.

There are four large catalogues lately published by four departments of the United States government, viz.: Mr. Boss's declinations of 500 stars, by the State Department; my own catalogue of 2,018 stars, both right ascensions and declinations, by the War Department; Prof. Newcomb's, of 1,098 stars, by the Navy Department; and the Coast Survey list of 1,463, by the Treasury Department. The first is admirable in all respects; Prof. Boss took a great deal of pains and spent much time; but the right ascensions are lacking. My own work was for a practical end, which did not allow either the means or the time for so complete a discussion of four times as many stars; but I think a great many trustworthy proper motions were detected by its means. I hope by-and-by to observe the few stars in this catalogue which are now at all uncertain, owing to lack of older observations. Prof. Newcomb's catalogue is, for the smaller non-fundamental stars, much in the same condition as my own. The coast survey computers have contented themselves with the rather inaccurate proper motions of the B. A. catalogue, and with a rather defective collection of modern authorities; so that the present errors of their declinations are large. They do not add right ascensions more accurate than to whole seconds of time, which is, of course, entirely proper for their purpose. In order to completely utilize for theoretical purposes the three government catalogues first mentioned, Mr. Boss's needs to be completed by adding right ascensions, and the other two — in fact all three — by revisions wherever the material at hand was deficient.

In the southern hemisphere, and especially in the southern-

most half of it, there are valuable discoveries by the Melbourne observers and by Mr. Stone; and in the northern hemisphere, and part of the southern, we have Auwers' Bradley and the other compilations which have been just mentioned. I estimate that probably two thousand stars in the whole heavens have proper motions exceeding 0″.1 (a tenth of a second) annually, which have already been calculated by least squares, or some similar process, and only need revision.

The field of investigation in this direction now open is, of course, boundless; what needs to be done for the next twenty years is mainly a critical study of the materials, their reduction to a fixed epoch and least square calculation therefrom, and adding (probably) a smaller amount of new observations than has been accumulating in a routine way, without much plan, for the last half century; to say nothing of the great catalogues which have been better planned. I have not mentioned these newer catalogues in detail as they are well known.

For the epoch 1900 it ought to be possible to construct a catalogue like that of the British Association for 1850 in general plan, but complete to the seventh magnitude, and of great accuracy both in its positions and proper motions, and before that time we ought to have a definitive settlement of the problem of the solar motion, which will go far to give us definite notions of the general structure of the universe. For I have long ago shown that, in this way only can we find much more about the average stellar distances.

FOURTEENTH ANNUAL MEETING.

DECEMBER 26, 27 AND 28, 1883.

PROGRAMME.

WEDNESDAY, DECEMBER 26th. 7:30 P. M.

Business Meeting — Reports of Officers.

THURSDAY, DECEMBER 27th, 9 :30 A. M.

Unfinished Business.

Paper: "On Ancient Villages among Emblematic Mounds."—Rev, S. D. PEET, Clinton.

Paper: "On Elephant Mounds."—Rev. S. D. PEET.

Paper: "Game Drives on the Mississippi River."—Rev. S. D. PEET.

Paper: "The Man Mounds."—Rev. S. D. PEET.

AFTERNOON SESSION, 2:30 P. M.

Paper: "On the Distribution and Migration of Birds in Outagamie and Brown Counties."—S. D. WILLARD, Depere.

Paper: "On the Principal of Duality."—Prof. C. A. VAN VELZER, Madison.

Paper: "Analysis of Water from Florence, Wis." PROF. W. W. DANIELLS, Madison.

Paper: "The Wisconsin Geological Survey on Upper Silurian Fossils." Dr. F. N. DAY, Wauwatosa.

Paper: "Variation in Attraction due to the form of Attracting Bodies." D. P. BLACKSTONE, Berlin.

EVENING SESSION, 7:30 P. M.

Unfinished Business.

FRIDAY, DECEMBER, 28th, 9:30 A. M.

Paper: "On the Driftless Area."—Prof. R. D. SALISBURY, Beloit.

Paper: "On Metamorphic Rocks."—Prof. R. D. IRVING, Madison.

Paper: "The Variation in Attraction due to the form of Attracting Bodies." D. P. BLACKSTONE, Berlin.

AFTERNOON SESSION, 2:30 P. M.

Paper: "On the Relation of Greek Art and Religion."—Prof. J. EMERSON, Beloit.

Paper: "The Democracy of the Ancient Germans."—Prof. W. F. ALLEN, Madison.

Paper: "The Results of the Caroline Id. Eclipse Expedition."—Prof. E. S. HOLDEN, Madison.

Paper; "The Genera of the Family Attidæ."—Prof. G. W., and ELIZABETH S. PECKHAM, Milwaukee.

ANCIENT VILLAGES AMONG EMBLEMATIC MOUNDS.

Rev. S. D. Peet, Clinton, Wis.

The subject which the author has set before himself in the heading of this paper, is an important one and yet one which is attended with peculiar difficulties. It is not an easy task to take the silent monuments of the dead and to people them with a living race. Even historic scenes when once deserted and left in silent ruin are difficult to rehabilitate, but prehistoric scenes much more. Of all the prehistoric works none are more mysterious and difficult to explain than are the emblematic mounds. There is an obscurity about them which almost baffles investigation. The people who built them are shadowy and unfamiliar as ghosts. For one to enter into the study of their habits and ways and to describe their modes of life is almost presumptuous. The tokens are, however, before us. Other explorers have studied monuments and from them given descriptions of unknown people.

The villages of the emblematic mound-builders may, indeed, be different from the buried cities of the east and their village life may contrast with the civilized state; yet this is in accord with what is known concerning the mysterious people. We are not to consider them as a civilized race, but rather as a rude and almst savage people. Their villages are merely the habitations of a rude people and are to be studied as much in their connection with their surroundings, as in the works which are found upon their village sites. This point will be considered by the reader as he follows the line of thought, for there are many elements brought into the account and they are all to be as exponents of the one surrounding system. The treatment of the subject is mainly from an archaeological standpoint. The only object of comparison is the villages of the later Indians. These, however, differ so much in their tokens from the villages of the earlier race, that they become sources of confusion and close anal-

ysis is required to distinguish the two classes of works. The author has been careful to notice the differences between the two and to make the subject definite. Our investigation is to be among emblematic mounds and not other tokens and the villages of which we are to speak are the villages of this unknown people. There are several heads or divisions to the snbject:

I. The existence of village life among the emblematic mound-builders.

II. The probable characteristics of these villages.

III. The identification of these peculiarities or traits in certain localities.

IV. The comparison of different localities as exhibiting the same characteristics.

V. The contrasts which are presented by certain groups, concerning which there are doubts whether they contain village sites or not.

I. The existence of village life among the emblematic mound builders is a point which has very great interest, and which deserves especial attention. The proofs of this have been lacking hitherto, although there are many facts which have rendered it probable.

(1). In the first place it has been supposed that the mound builders were in that stage of culture which would render the village a necessity. They were passing out from the stage of savagery and from a purely hunter's life into the agricultural state. This is evident from the fact that garden beds are found associated with the mounds. These garden beds differ from the corn fields of the Indians as much as the elaborate works and effigies differ from the ordinary burial mounds, and show that the mound builders were superior to the later tribes.

Villag» life existed among the Indians. With them there was the custom of raising the cereals combined with the chasing of wild game and the subsistence upon fish. With the mound-builders the same modes of life may have prevailed, but village life would be more marked, inasmuch as their culture was more advanced. The relics which are found, as well as the works, indicate that a peaceable condi-

tion prevailed among the builders of the emblematic mounds. These relics have been discovered in various parts of the state, and show that the copper age had been reached by this unknown people. We do not say that the copper age and village life were identical, but there was an approximation to the bronze age, and we know that the bronze age was characterized by the prevalence of villages. Mining was probably known to the mound-builders, and this would render probable that village life had been reached.

(2). Again, the tradition and known customs of the later tribes would render it probable that the mound builders dwelt in villages. The remark of Miss Fletcher in reference to the Dakotas is that they have favorite places to which they resort for generation after generation, and, judging from the tokens furnished by the emblematic mounds, we should say that the same custom prevailed among them. Village life is known to have existed among the Indians of this very locality, where the animal mounds are found. There are many sites of villages which have been identified by history. These differ from the sites of the villages of the preceding race, but are often in the vicinity of extensive groups of emblematic mounds. The record of early explorers and travelers is that the natives dwelt in villages, and the early maps locate these villages.

(3). The succession of races betokened by the earthworks would show that village life had existed in the earliest period. It is sometimes the case that the village site of a later tribe will appear with a certain class of earthworks in the vicinity, which differ from the works which belong to the emblematic mound builders, yet render it probable that both people built their mounds near their villages. It is one point for the archæologists to decide while studying the mounds and earthworks, which works belong to the later Indians and which to earlier mound builders.

(4). The universality of village life among uncivilized races would prove that it existed among the emblematic mound builders. This is a point which we shall not stop to discuss, but shall take it for granted. The similarity of village life is the point which we are to

examine. In reference to these there is, perhaps, more uncertainty than in reference to the existence of villages. The study of the native life of the wild tribes may furnish us some information in reference to their characteristics and from our knowledge of the later tribes we may ascertain what were the elements of the village condition, but it is mainly by analogy that we predicate that such elements existed among the mound builders. We carry with us information from the living races to the extinct and by one picture learn to interpret another filling up the outlines which have become obscure by the wear of time and interpreting many things which would otherwise be inexplicable.

Again, II. The characteristics of village life are exhibited or made known. These characteristics are as we have seen, the selection of a locality favorable to subsistence, the selection of a spot which would be convenient of access, well guarded by its natural surroundings, and which should be dry and favorable for the erection of houses. The tokens that a village was located would be found in the existence of mounds, earthworks and effigies around an enclosure, in such a position as to give the idea of defense. The additional discovery of caches, springs of water, and other signs of permanent residence, would be additional proof. The existence of burial mounds in the vicinity of outlooks which might serve as defenses and of altar mounds in the vicinity, would prove that the locality had been occupied as a place of residence. The existence of game drives and of trails and gardens would be still further evident. The early explorers and travelers all speak of villages. It is very seldom that Indians were met with outside of their villages, but there were many localities where villages were prevalent. The early maps have given the location of many of the villages. According to these maps the villages were situated on the water courses and lakes, and were connected to one another by trails. Several villages were situated on Green Bay, others on Lake Michigan, and still others on the Mississippi river.

The study of these villages may give to us some hints as

to what constituted village life. We find striking analogies between the locations of the earlier and the later races, for the same places in which history describes villages to have existed contain many monuments, which were evidently works which belonged to the emblematic mound buildess. The centers of population were the same and the same spots were chosen for the residences of the two races. The exploration of the mounds reveals a striking similarity between the modes of life and in many places should seem that these modes were carried out in exactly the same places; the hunting grounds being the same, the village sites the same, the defenses by lookouts the same, the burial places in close proximity and all of the departments of life having been conducted in the same scenes and having been repeated by the two races. The only difference between them being in the emblematic character of the mounds which the earlier race erected. The characteristics of the villages of the earlier race we conclude will be learned from the description of those of the later races.

The early travelers and explorers found Indians dwelling in villages, and from their descriptions we learn the characteristics of village life. These characteristics are as follows: 1st. The selection of a locality favorable for hunting and fishing, and at the same time accessible by rivers and trails from other villages and from distant parts of the country. 2d. The selection of a favorable spot for residence and the erection of houses or huts on some rise of ground overlooking a stream or lake. 3d. The erection of certain defenses, either stockade or a lookout station. This was a general habit, although there were many villages in Wisconsin which had no stockade and no visible defense. As a substitute, however, the villages were placed on land somewhat remote from the water course, and so hidden by surrounding forests or hills that they could not be approached without due warning being given. 4th. There were generally near these villages burial places, either the rude structures or graves protected by logs or rude planks, and the hollow logs hung in trees near the stream or lake. 5th. There were generally near the villages garden beds or corn fields, and

always springs of water. 6th. In certain localities there were arrangements or contrivances constructed from wooden stockades by which game were entrapped. This was not universal, but there are certain sketches in certain books, especially in Champlain's works, which illustrate the fact. The Indians of Wisconsin are not known to have constructed game drives, but the point is an interesting one. 7th. There are various traditions in reference to the attachments which the Indians had for the localities where the villages were situated, and in reference to the religious ceremonies which were observed in or near their villages. These seven particulars we have here mentioned, because they illustrate certain points which we have discovered in connection with the emblematic mounds. The identification of a village site surrounded by emblematic mounds, has led to the discovery of the same characteristics, and proves interesting on this account. The mere discovery of a village site would not avail much were there not some further information gained from it. In describing the villages of the emblematic mounds, we shall draw the comparison and speak of the specific items or elements which seem to have been common among the villages. We shall first refer to one particular village and then show what its characteristics were and then draw the comparison between this particular village and other supposed villages and from the aggregate draw conclusions in reference to what constituted village life.

The identification of a village site among the emblematic mounds is an interesting fact,and one worthy of notice in this connection. In the first place it proves that the mound builders dwelt in villages. This has indeed been rendered probable by other facts, but has not been hitherto proved for a certainty. In the second place it furnishes a clue to a certain class of works which have been supposed to mark village sites, but concerning which there has been also much uncertainty. These works have been discovered by the author in various localities and the conjecture has often arisen that they were village sites. The comparison between them and the works which are known to have surrounded a village now clears up the uncertainty.

The identification of certain village sites will next engage our attention. The method which we have pursued in identifying these sites is the one which we have already prescribed. We have fixed in our mind what was the probable characteristics of village life and then have studied the mounds to see if these characteristics could be found in them. We have, in fact, taken the picture of native society as we have ourselves painted it and then have sought a frame for the picture in the emblematic works. This is, in our opinion, the only way in which a village site could be identified. It was because we had framed some conception of the people who erected the mounds and from the study of their works had come to understand something of their mode of life that we have made the discoveries which we have.

The first place where a village site has been identified by the writer is at Great Bend, on the Fox river, thirty miles west of Milwaukee. Here is a series of works which Dr. Lapham has described, and which have proved to be interesting on many accounts. (1) A few words in reference to the locality will be in place. Great Bend is situated at the edge of the extensive forests which formerly stretched along the lake shore, throughout the whole length of the state. At a point where the extensive system of prairies which characterizes the scenery of the interior of the state intrudes upon the forests near this place is an extensive marsh, wherein are immense tracts of land filled with wild oats. There are upon one side of the stream forests which abound with game, especially with the beasts of prey and with the larger class of birds, such as the wild turkey, wild goose, hawks and eagles. On the other side are the prairies, where formerly abounded the grazing animals, such as the buffalo, elk, wild deer, and the great variety of prairie birds, the marsh and the river forming a favorite resort for ducks and wild geese, and water fowls of various kinds. There are in the vicinity many small streams and ponds where beaver and muskrat would be numerous. The locality is, then, a favorable one for the permanent residence of a people.

The character of the region can be learned from the map which we here present.

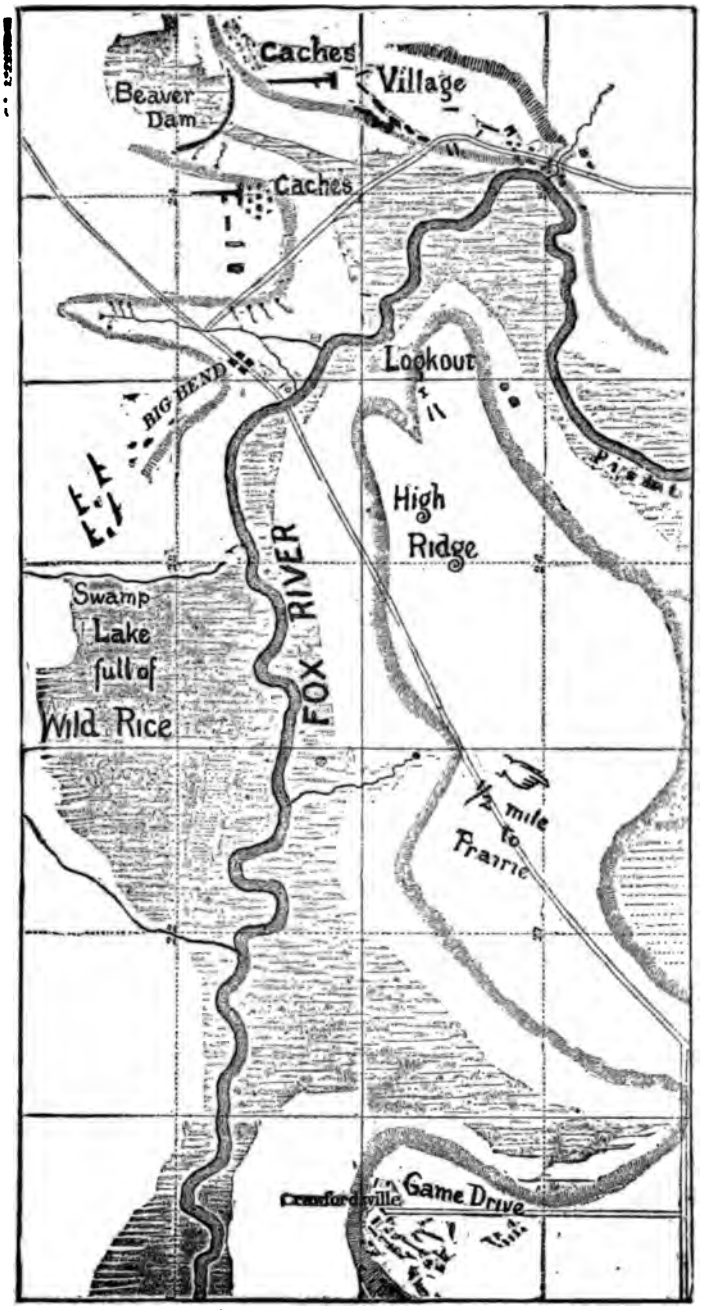

Caches
Village
Beaver Dam
Caches
Lookout
BIG BEND
High Ridge
FOX RIVER
Swamp Lake full of Wild Rice
½ mile to Prairie
Crawfordville
Game Drive

Fig. 1.

Another point worthy of notice is that in the vicinity there are high lands which command extensive prospects. At this point there are extensive ridges which form prominent points from which extensive views could be gained. The geological formation is here noticeable. The Great Bend was caused by the damming up of the stream in the glacial period by great ridges of gravel which turned it from its course, deflecting it to the eastward, for six miles or more. At the point where the village is located the river bursts through the barriers, leaving a high knob of land upon the west side and gentle swells of ground upon the east, making an extensive lake, or reedy and marshy place to the north of the ridge, and throwing the region to the south open to the ravages of fire, so that the prairie crept up to the very edge of the stream at that side. On this ridge there are mounds and earthworks which correspond to altar mounds and outlooks which have been discovered elsewhere. In approaching the locality from the north one is impressed with the sightliness of this bluff or ridge, for at many intervals the ridge can be seen several miles away. It is singular that as the writer approached it there were open spots in the wooded hill top which attracted special notice, and that these spots proved to be the very localities where were outlooks and sacrificial mounds.

On reaching the locality the first thing which attracted attention was the discovery of a panther effigy of remarkable size and well defined shape. (See Fig. 2.) In following the outline of the effigy and reaching the head, it was discovered that the land was broken by a great number of pits, which proved to be the caches of the village. These were situated on the edge of a small pond, and near a beaver dam, but were hidden away in the forests and would not have been noticed except for the proximity of the effigy.

There are many effigies which seem to guard caches as this does, but none had so far been discovered near any vilvage site. Dr. Lapham describes one as situated at Indian Prairie. Here the effigy is represented as guarding a low mound. In the mound was a pit and upon the surface of the soil were corn hills. The figure is given herewith for the

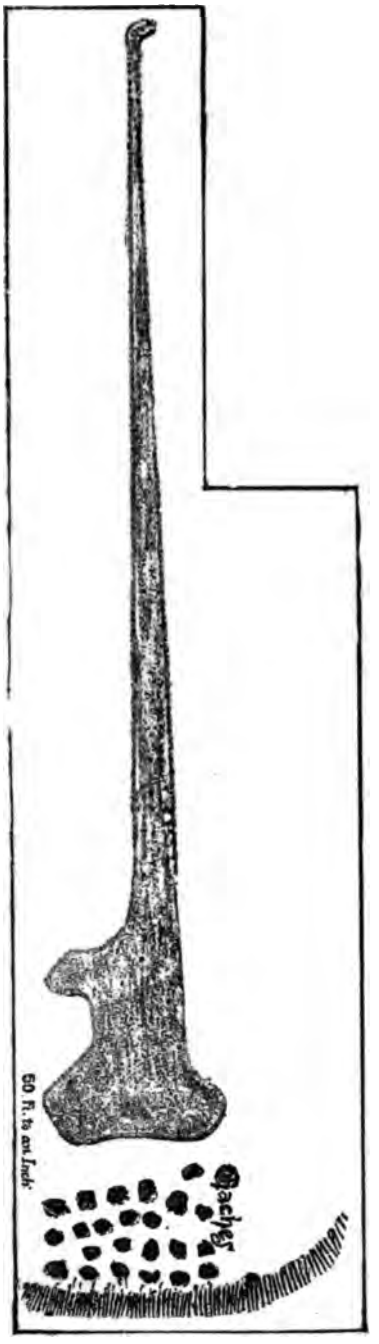


Fig. 2

sake of comparison. The effigy of a panther guarding the caches at Great Bend is much more symmetrical than that at Milwaukee. Dr. Lapham says that this ground is covered with a present race of Indians who occupied the land in this vicinity down to a very late period. The figure may be considered as a rude representation of a wolf or a fox guarding the sacred deposits before it. Both of these are of so little elevation as to be observed by the passer-by. The body of the animal is 44 feet and the tail 63 in length. The effigy which we discovered as guarding the caches near the beaver dam was accompanied by several large platforms o long mounds. One of them at right angles to the body of the effigy and another several rods distant to the west; these two having a parallel position. The caches were very observable. There were twenty or more of them scattered over the surface of the hill, but all of them in front of the effigy. Passing over the small stream where was formerly a beaver dam we came to other caches similarly situated, but without any effigy near them. These were more numerous than upon the other side, but were fully as well as guarded, as they were hidden in the forest and were in the rear of a rise of ground, on which we afterward discovered the site of the village itself. The existence of these caches was to us significant for it betokened permanent residence. We have previously noticed the advantages of the locality. The forest, and marsh, and prairie combined would lead one to expect a village somewhere in the vicinity. The fact that extensive works had been described also led to expectancy but the discovery of the caches put us on the alert.

(4) The situation of the village itself impressed us more than the caches. It was on a rise of ground from which the water flowed in every direction. The stream which we were crossing formed a barrier upon the north side. The swale and beaver dam and low land in which the stream headed formed also a barrier to the spot on the east, separating the village from the forests, making the approach to it inaccessible on that side. The river is some distance to the west, and flows at an angle toward the tongue of land on which the

village is situated. Between the village and the river the land is low, and so the spot is inaccessible except at one point. At the south of the village site was another small stream, which also heads in the swamp or springy land in the rear of the village. The low land adjoining is covered by a jungle of bushes and small trees, a fit place for the hiding of wild animals, but abounding with berries and wild fruit of various kinds. The situation of the village on this rise of ground was remarkable, because the spot was so favorable in every respect. The peculiarity of the site is that all the requisites of village life were furnished by it. It is well guarded and drained, is surrounded by forests and prairies, is well situated in relation to the river, the rice swamps, the beaver dam and springs of water, was in a locality where the means of subsistence were furnished in great abundance. Additional to these advantages was the fact that, on the opposite side of the river, less than a mile away, is the high bluff to which we have referred, and on this bluff there proved to be mounds which undoubtedly served as outlooks. The protection of the village was thus secured by the locality as well as the means of subsistence. The situation of the ground on which the village was located was in the midst of swamps and low lands, which also served for protection.

The evidence that this was a village site is as follows:

(*a.*) The selection of the locality with a view to subsistence. The place for storing grain was furnished by the hillside to which the approach was easy from the village itself, but was difficult from any other direction. The presence of springs near the village but in the rear of it secured to the inhabitants a supply of water from which they could not well be cut off. The presence of the game-drives shows that the inhabitants depended upon wild game as well as the products of the soil for their subsistence and the marshes in the vicinity abound in wild rice. There may have been the cultivation of maize, but no garden beds have been discovered in the vicinity. The means of subsistence were furnished by the forest, streams, lakes, and prairies.

(*b.*) The beauty of the spot and the advantages furnished by the well-drained and shaded ground would indicate that it had been used as a village site. Not all villages are as favorably situated as this, but the advantages were too manifest for any one to deny them in this case.

(5.) The artificial works of the locality impressed us. The first object which engaged attention was the effigy of a huge panther. This was situated on the edge of the hill at a point where the small stream breaks through into the valley of the Fox river. The effigy stretches along the brow of this hill overlooking the valley of the river, its immense body and tail forming a guard against approach to the caches on the banks of the stream above, and protecting the village site at this point. The effigy is a peculiar one; it represents the panther as standing with head erect, the legs straight, but the body extremely attenuated, as if the animal was in the last stage of starvation. The position of the effigy was also peculiar, while its immense body and tail stretched along the hillside toward the little stream at the north, and terminated at the very edge of the bluff in this direction. Its head fronted the opening to the village itself, and the attitude was as if the animal was looking directly into the village, and was there watching and waiting for some object that might satisfy its appetite. Such at least was the impression made upon the imagination by the figure. The contrast between this effigy and the one guarding the caches in the rear of the village was marked. In the first place the effigy was much longer and more definitely marked. Again, it was situated on the brow of the hill, overlooking the land adjoining. Its attitude and shape were peculiar. Our conclusion was that the effigy was stationed near the village site, with the head fronting the opening, in the attitude as if guarding the gateway.

At the entrance of the village site there was a series of oblong mounds. These mounds were arranged so as to make a double guard; two of them formed an angle toward the north, at the opening of which was the panther effigy two others formed an angle to the south, leaving openings at either end and between them, but so arranged as to form

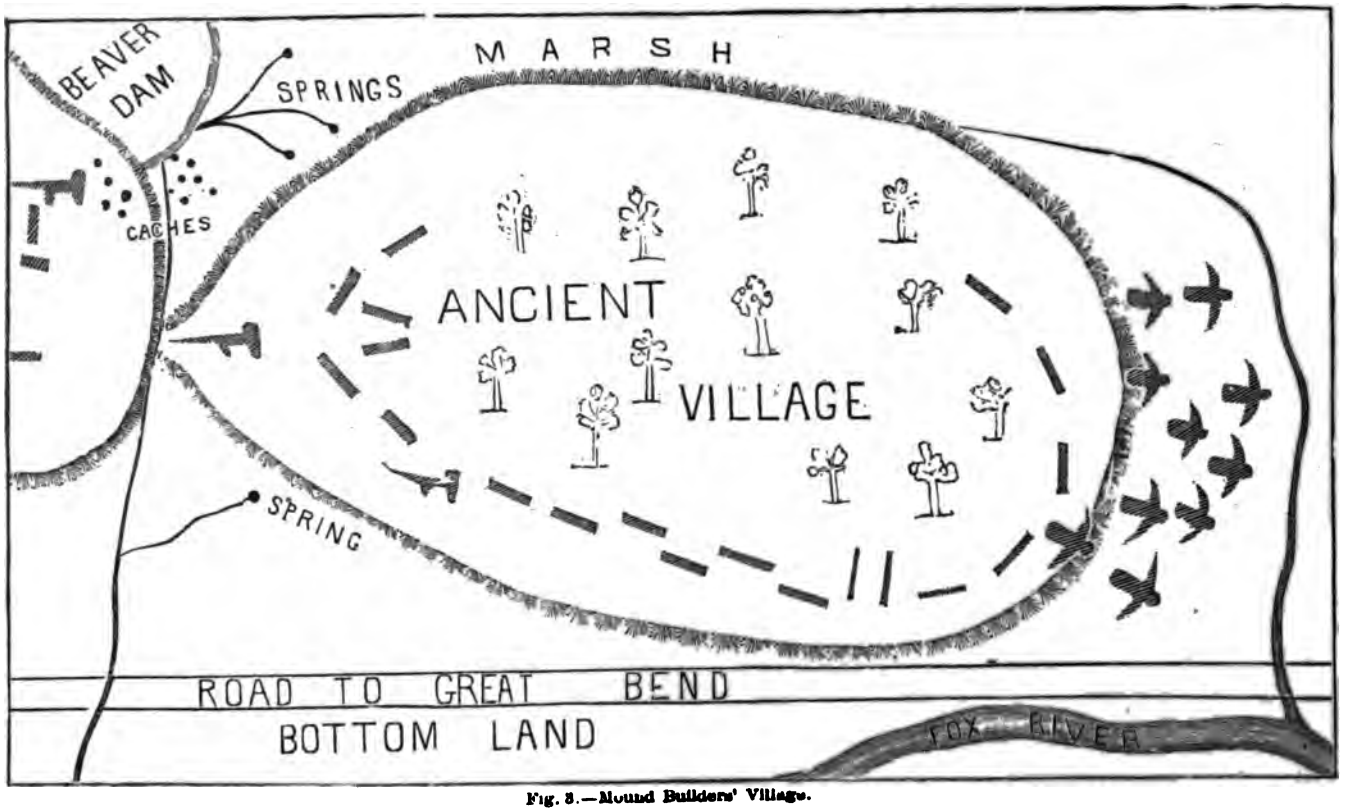


Fig. 3.—Mound Builders' Village.

a guard to the entrance; beyond this, following along the brow of a gentle slope of land were other oblong mounds. A little further on to the south and west was another panther effigy, the effigy this time situated at an opening between the oblong mounds, but with the body running parallel with the mounds, and thus forming a guard across the opening on the other oblong mounds and effigy mounds. Here the effigy was that of an eagle or hawk which seemed to guard the village on this side, and formed the bend of the wall. Other oblong mounds were situated on the edge of the rise of ground, forming a quasi wall at the south of the enclosure, and turning back toward the north formed also a partial wall upon the east side. The situation of the village was on a rise of ground within the enclosure, which was formed by the oblong mounds. There was no evidence of a stockade, but the earth-works so surrounded the village and site that they may have served as a partial defense. The entrances to the village were also guarded by mounds which were peculiarly arranged. The one where the panther effigy was had a double line of oblong mounds; the middle entrance was also guarded by oblong mounds, but had no effigies near it.

The means used for defending the locality prove that it was a village. The enclosure covered an area of about one hundred and sixty acres. The mounds surround the edge of the enclosure forming a fragmentary wall. They needed only to be attended with stockades to form a splendid defense against approaching enemies on three sides, while on the other side the marsh and low land furnished a natural defense. There was a double advantage or use to these oblong mounds, while they furnished platforms from which warriors could shoot approaching enemies. They also furnished platforms on which the inhabitants could sit and watch the busy life of the village within the enclosure. The entrance and covered ways would indicate that there was a form of arrangement of the houses, possibly streets ran through the villages, and a square may have existed in the centre. Effigies guarded the village at either side and gave the village the sense of protection. (See Fig. 3.)

The spot where the village is located is a beautiful one. It is at present covered with a sturdy growth of oak trees and is a very attractive place. The shade of the trees protects the spot from the glaring heat of the sun during the warm seasons, end the surrounding forest would protect also the village from the sweeping winds and drifting snows during the cold season. The presence of the caches and of the effigies and oblong mounds show that it was a permanent dwelling place. As an additional protection to the village, there were at the south of the village site a large number of bird effigies. These are scattered over the surface of the hill at this end of the village forming an abatis which might serve both as a screen for hunters and as a guard against the approach of an enemy.

The discovery of burial mounds in the vicinity indicated also that it was a place of permanent residence. These burial mounds were on the lowland adjoining the river. They are so situated that they form an outlook along the valley of the stream, but are in close proximity to the village site itself. These mounds have not been excavated but their shape and size would indicate that they were burial mounds.

(6.) The outworks, or groups of mounds in the vicinity of the village are worthy of notice. There are mounds on land belonging to Mr. Rose, on section 25, one mile or more distant. These mounds are situated near the line of the bluff overlooking the valley of the river, just at the point where the stream and the marsh join. These mounds are nearly obliterated, and their design could not be ascertained. They were, however, so situated in relation to the river and marsh and land adjoining, as to give rise to the idea that they were used possibly for game drives. The effigies were in a wheat field and could not be identified. The out-works which most interested us were those situated on the edge of the same marsh or lake, three miles to the west. These have been described by Dr. Lapham;* he calls them the mounds at Crawfordsville, although there is no village there and never was. The peculiarity of these works is that they are

*See Lapham's Antiquities.

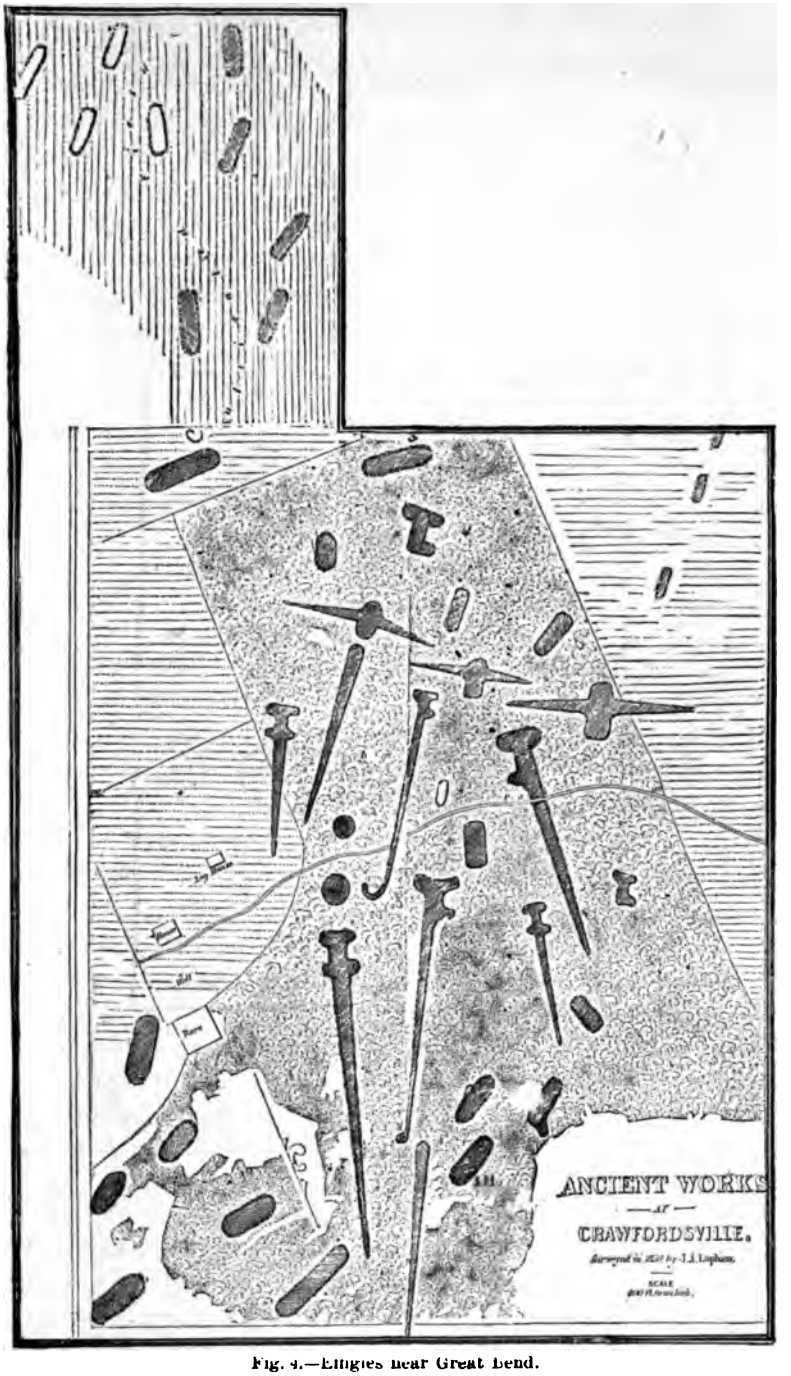


Fig. 4.—Effigies near Great Bend.

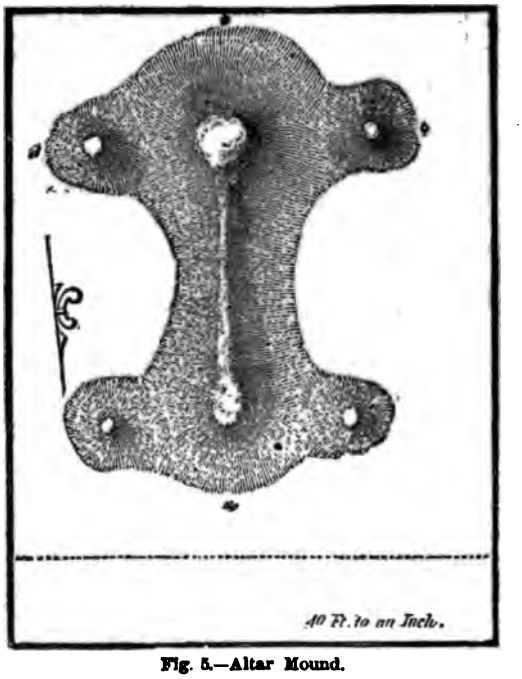


Fig. 5.—Altar Mound.

stretched along parallel with one another, and form a group resembling others which we have elsewhere identified as game drives. An illustration of the group is here given It will be noticed that the effigies are peculiarly situated and shaped; they are unnaturally prolonged, and so placed in reference to one another as to give the idea that they were intended as screens for hunters, and as traps for wild game. The arrangement of the ridges is not exactly in parallel lines, but at angles, each effigy serving to make a narrow place through which the animals would need to pass, and the oblong mounds forming guards to each opening, so that an additional opportunity for shooting the game might be furnished.

(7.) The most noticeable peculiarity of the region was the discovery of a so-called altar mound. We mention this last because it is the most suggestive and because it brings out the point of analogy between the village life of the mound builders and that of the Red Indians. There are no traditions connected with the locality but the religious significance of this group of works is apparent. On the summit of the hill overlooking the village itself is a small group of mounds, consisting of three oblong mounds and one effigy. The oblong mounds are situated on the brow of the bluff, and apparently were designed to serve as guards to the effigy. The effigy is what we have called an altar mound, as it has the same shape and situation with other mounds which have proved to contain altars, and is one which has been found in various particulars. The figures of it will illustrate the point. (See Fig. 5.) It is a mound formed by a combination of five mounds in one, the whole group making an effigy of an animal resembling the horned toad or frog. A ridge which connects two tumuli or conical mounds, forms the spine; four conical mounds situated at the corners formed the hips of the animals; the projections which represent legs are blunt and without particular resemblance to the animal formed. The distinguishing peculiarity of the effigy is that its form is an exact repetition of the shape of the bluff. The projections in the mounds imitate on a small scale the spurs on the side of the bluff itself, the two making a double effigy. As an additional feature

proving the religious character of the works, we may mention the existence of two massive burial mounds. These are situated on the low land below the bluff and between the bluff and the river. They are massive, and may have been the place where the bones of those who had been residents of the villages were borne after death and deposited. The altar mound was so situated that it could be seen from a great distance. If there were fires lighted on it they would gleam not only upon the waters and the river below, but they could be seen for miles away. There is no doubt that this was the place where sacrifices were offered and where religious ceremonies were observed. The group furnishes a most distinguishing peculiarity of village life.

One point additional which we have not mentioned is the line of communication of their villages in the same region. The trails which communicated between the villages of the Indians may prove an additional feature. These trails are known, and have been identified and traced by the author. The situation of the village on a well known route is at least worthy of study.

It was situated on the line of the dividing ridge, which has been used from time immemorial for a route from Lake Michigan to the Mississippi river. The route leads from Milwaukee through Muskegon lake, on through the Great Bend, crossing the Fox river; then at this point passes across the prairies to the west until it reaches the Rock river. Here it divides, one route turning south towards Beloit and Rockton and another towards Lake Koshkonong and the Four lake region where Madison now is. Passing from here the route crosses the dividing ridge between the Wisconsin river and the western branches of the Rock river, until it reaches the Blue Mounds. From the Blue Mounds it crosses prairies to the Platte Mounds and reaches the Mississippi river among the bluffs somewhere about Cassville. At each of these localities there are extensive works, showing that the same population and the same thoroughfares prevailed in prehistoric times which prevailed in the historic, the modern villages and cities having been placed on the very same sites where the ancient villages were.

The ancient trail was supplanted first by the stage route. The railroad has now taken the place of both. This village site has not been reached by the railroad although it was a favorite project to connect the interior with the lake by this route. The first plank road through the Milwauke mounds was built from Great Bend and Muskegon to Milwaukee. The first railroad struck the site of another native village, that at Waukesha and then passed on to the west. Proof furnished by the thoroughfares of modern days may not seem to be in point, and yet we take the ground that the natural advantages of the country have led to the choice of the same localities for residences, the same routes for travel, and the same spots for centers of population throughout the whole series of changes which have occurred both in historic and prehistoric times.

The proofs that this was a village site do not need to be dwelt upón longer. We only recapitulate the points which have been illustrated in this case that we may understand what are the characteristics of village life among the emblematic mound builders generally. We have 1st, the situation of villages as regards the means of subsistance, (a) on the edge of a forest and near a prairie abounding in wild game; (b) in proximity to wild rice swamps and near streams and forests where fruits and grains were abundant, (c.) it was near rivers and lakes where fish could be procured, and may have been a favorable position for the raising of maize and horticultural products. 2d. The character of the ground on which the village was located. (a.) It was isolated from the river and from the surrounding country. (b.) It was a favorable place for drainage and furnished favorable places for hiding their stores of grain.

3rd. Provisions for defense: (a) fragmentary walls placed on the edge of a hill; (b) effigies placed at the openings between; (c) a covered way, protecting the entrance to the village.

4th. The outworks accompanying the village consisting of (*a*) burial mounds; (*b*) game drives; (*c*) effigies protecting it; (*d*) look-out mounds in a prominent position; (*e*) other works designed to protect and to furnish means of subsistence.

5th. The evidences of religious observance: (a) the presence of the effigies surrounding the enclosure; (b) the number of burial mounds in the vicinity; (c) the altar and place of cremation.

6th. The situation of the works as related to the surrounding country: (a) its connection by streams and trails with other centres of population; (b) its location on a lake or river; (c) the character of the country surrounding as furnish opportunity of changing signals with distant points.

7th. The last characteristic and the chief is the presence of the enclosure. In this case the enclosure was marked, and affords undoubted evidence that a village was located here.

III. These evidences of village life have been dwelt upon, for they are essential in fixing the points where other villages were located. The comparison between this village of the emblematic mound-builders and the known villages of the later tribes have given us certain characteristics, but the comparison is hereafter to be between one village of the unknown people and other villages which may be presumably fixed upon. It is a method of gradual approach.

IV. We proceed, now, to consider other village sites, and to compare these with the one which has been identified. The second locality where an ancient village has been identified is at Waukesha. The points of .resemblance between the two localities are as follows:

1st. The locality was favorable for the subsistence of a large population. The same forests which intervene between the Fox river and the lake stretch northward, and here forms a border line between wood land and prairie, and between one form of natural products and another, thus affording a double supply of wild game and of nature's cereals and fruits. The locality is similar to that at Great Bend, in that there was an extensive prairie bordering upon an extensive marsh, and similar surroundings of high hills, and the same variety of soil. At this place there were formerly extensive groups of emblematic mounds, some of them on the prairie itself and some of them in the openings surrounding, and some on the summit of hills in the vicinity. It is evident from the na-

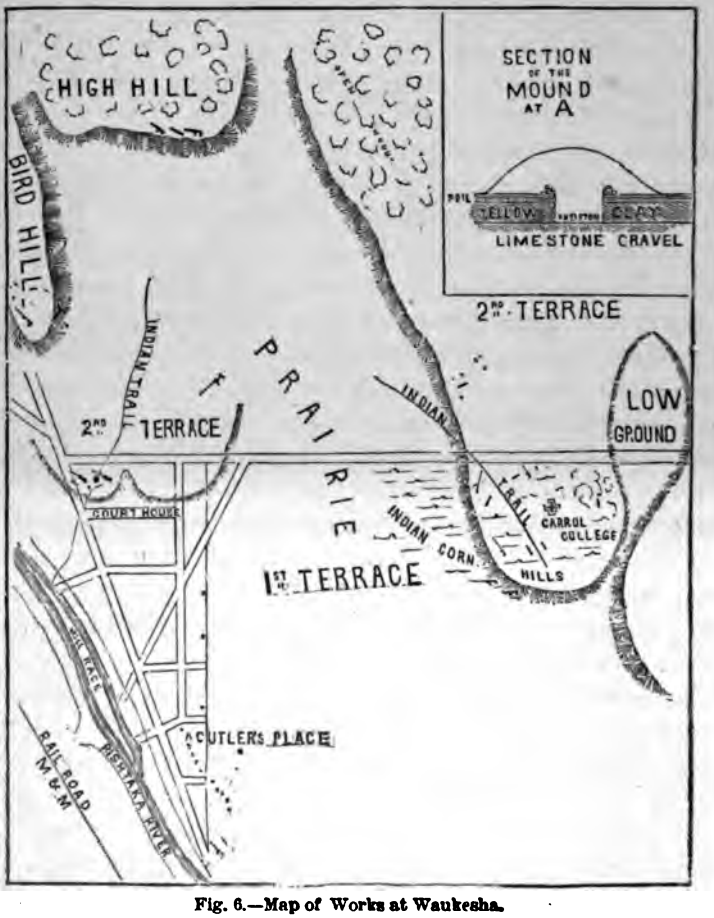


Fig. 6.—Map of Works at Waukesha.

ture of the works that here had been a center of native population. See map, Fig. 5.

The Fox river, also here furnishes a similar expanse of marsh filled with wild oats. The advantages for gaining a subsistence from the forests, and the stream and the open prairie are similar to these found in the previous locality. There are signs here of cultivation of the soil. (See Fig. 6.) We quote from Dr. Lapham: "Much of the ground about Waukesha was, in 1836, covered with Indian corn hills or remains of the recent culture of maize. In this locality as in numerous others, the mounds occupy the highest ground and the points of hills and other places whence the most extensive view, both above and below can be obtained. The town of Waukesha stands on a slightly undulating plain surrounded by hills, forming a fine amphitheatre, which in ancient times was doubtless crowded, as it is now, with numerous population. One fact is important in this connection —the mound builders occupied the same localities that are now the favorite resort of the present Indians, who still often make use of the mounds for the burial of their dead. They have a kind of veneration for them which may be the result of a lingering tradition. We need not look to Mexico nor any other country for the descendants of the mound builders. We probably see them in the present red race in the adjacent regions. Different tribes have different habits, and a stronger one may have overrun and swallowed up a weaker and then changed its customs and destroyed its institutions.

The corn hills found in this vicinity if they do not prove that the mound builders were agriculturists, or that here was an ancient village of the mound builders, at least they show the advantages of the locality. There are caches near Waukesha. A gentleman, long resident of the country, who owns a farm one mile east of the city, has pointed out a number of these caches on his land. They are like those at Great Bend, situated on the edge of a marsh and hidden away among deep forests. There are no effigies guarding these caches, and so we cannot ascribe them to the people who built the emblematic mounds. The coincidence, how-

ever, is worthy of thought for caches and corn fields indicate village residence.

2nd. The situation of the village with relation to lookouts and means of defense is worthy of notice. The reader will examine the map and compare it with the map at Great Bend and notice the occupied points in both. There are near the village high bluffs as at Great Bend. On these bluffs there are also emblematic mounds, which possibly were used as lookouts. Two of these groups overlook the village site; one which is not seen on the map is situated 1½ miles north of Waukesha. Dr. Lapham has described this group and a diagram is taken from his work. He says: "On a high and very commanding position" are three round mounds in front of four "lizard mounds." They are at the crossing of the old Madison road in the southwest quarter of Sec. 26 A. A sentinel stationed on them could give warning to the inhabitants on the approach of any hostile force long before they could reach the village. The lizards as in most other cases have their heads toward the south. "The general situation, distribution of the mounds as well as the topographical features of the country will be represented in the map." It will be noticed that they occupy three levels, those in the lower part mostly conical (probably Indian burial places those on the upper are on what may be called the second bank, others are on the high land east and south of the village.

We have referred to the turtle mound as forming a lookout. One of the most remarkable specimens of the turtle was found by Dr. Lapham at this place. The location of this would indicate that it was designed as a lookout to protect the village from approach by way of the river. The high bluff, called bird hill, is situated about one mile east of this. A description of this bird hill and its effigies has been given and does not need to be repeated. The village site was upon the grounds of Carroll College.

3rd. The form of the enclosure and the character of the ground are very similar to those found at Great Bend. Dr. Lapham says, the mounds form a quasi enclosure, and hence like many other groups of works, has been, by casual ob-

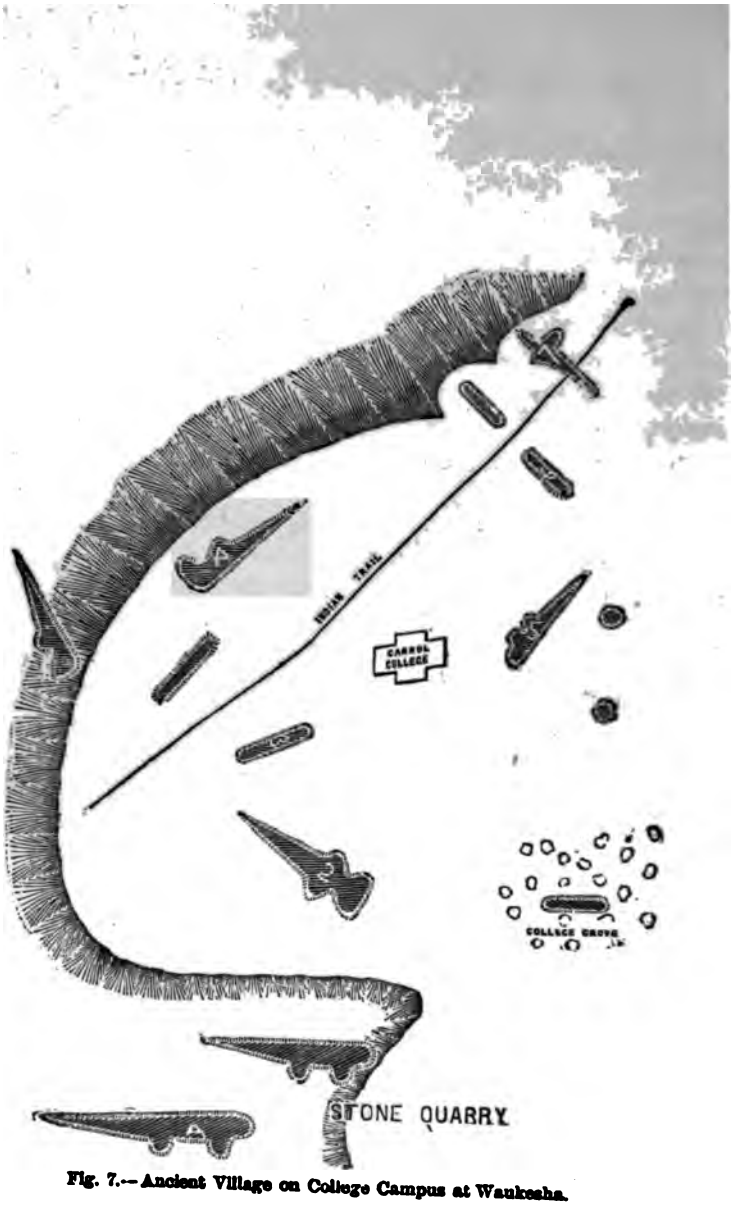


Fig. 7.—Ancient Village on College Campus at Waukesha.

servers, called a fort. If we were not well acquainted with the works in Ohio and elsewhere, which show that the mound builders were considerably advanced in military arts, we might suppose that this was intended for a rude fortification, but we can only regard it as an accidental arrangement, and not designed for any such purpose. Dr. Lapham's first impression of this locality was, however, a correct one. The mound builders' works were not all alike, and the system of defense which existed in Ohio would not be very likely to have appeared in Wisconsin. The emblematic mound builders defended their villages in a way peculiar to themselves. These fragmentary walls surrounding an enclosure were the means of defense by which the people guarded their villages. The ground on which the village is located is surrounded by low land, the same as that at Great Bend. The oblong mounds are erected near the edge of the rise of ground, and form a broken wall around the whole, making four sides of an enclosure, instead of three, as was the case in the former village. (See Fig. 7.)

4th. The effigies are quite similar. There are panther and wolf effigies both on the summit of the hill and upon its side. The effigies form a guard or defense to the enclosure and fill in the spaces between the oblong mounds. There is also a similar arrangement of parallel mounds which may be considered as forming the village, resembling that at Great Bend, but farther removed from the circumvallation and not so distinctly marked as a covered way. Still the analogy is worthy of notice.

5th. The covered way is another indication of a village site. There are or may be vilage sites which do not have this, but the parallel walls which lead to an enclosure may be generally regarded as an evidence that a village site has been reached. This is true, both among the emblematic mounds of Wisconsin and the earth-works of Ohio. Whether any such covered way can be found in other localities, it is true that in these two states it is peculiar to village sites. Marietta and Newark, Great Bend and Waukesha, may be compared, as the same feature is common to all.

6th. The outworks are similar to those a Great Bend. The hunting grounds which belong to this village are not found nearer than Pewaukee, which is about six miles away. There are works, there, however, which have been described by Dr. Lapham, and which have considerable resemblance to the works at Crawfordsville.

Another game drive has been discovered by the author on the very edge of Pewaukee lake. Here the mounds, which are all oblong mounds, are arranged in a peculiar position, making angles and open places along the brow of a bluff, as if the purpose was to make screens for hunters and traps for game. Whether these two series of works can be connected with the village site at Waukesha is a question, but we refer to them as among the items which make up the comparison between the villages.

V. Another locality where a village has been presumably identified is at Muscoda. The peculiarity here is that the enclosure was hidden away from observation by surrounding hill-tops, and was so remote from the river as to be entirely out of sight of any one who might be passing along the river. The enclosure is in a valley or swale, and has a number of effigies surrounding it. The effigies are all of them eagles. This village site has a number of game drives in proximity to it; two of them are situated on the same stream, only a mile or two away. The position of the enclosure is peculiar. The effigies and the fragmentary walls surround a swale, the land enclosed being much lower than that on which the effigies are placed. There are lookouts on a hill top three miles away, and there are nine wards or walls of defense in two separate lines between this place and the river. The spot is drained by waters of two small streams which make their head near this enclosure, Indian creek and Mill creek. The region is a favorable one for a village site. There are several particulars in which this enclosure resembles a village site.

MIGRATION AND DISTRIBUTION OF NORTH AMERICAN BIRDS IN BROWN AND OUTAGAMIE COUNTIES.

By S. W. WILLARD, West De Pere, Wis. (1883.)

This paper was prepared from recorded observations. It gives a systematic series of facts from which the generalizations of Messrs. Baird and Allen may be again applied.*

Brown County is well adapted for such a system of observation. The warm, short summers succeeded by the long cold winters mark distinctly each movement. The vernal and autumnal movements through these counties are large, thousands of migrants of species that are to some extent summer residents, pass us on their way to less crowded areas. These with the other migrants swell the throng to numbers almost incalculable.

To facilitate this study I have arranged the species in divisions based upon their migratory habits while in these counties.

CLASS I. Birds that are represented in this section throughout the year, but whose numbers vary in the different seasons. Members of this class may properly be called "residents."

†1. Parus atricapillus, L.
Black capped chickadee.

2. Sitta carolinensis, Gm.
White bellied nuthatch.

3. Cyanocitta cristata, (L.) Strickl.
Blue jay.

4. Picus villosus, L.
Hairy woodpecker.

5. Picus pubescens, L.
Downy woodpecker.

---

*Amer. Journal Sci. 1866, pp. 78, 184, 227 (Baird.) Scribner's Monthly 1881, pp. 932 (Allen.)

†Nomenclature from Coues' "Check list of N. A. Birds."

6. **Bubo virginianus, (Gm.) Bp.**
   Horned owl.
7. **Scops asio, (L.) Bp.**
   Screech owl.
8. **Strix nebulosa, Forst.**
   Barred owl.
9. **Cupidonia cupido, (L.) Bd.**
   Prairie hen.
10. **Bonasa umbella, (L.) Steph.**
    Ruffled grouse.
11. **Passer domesticus, (L.) Koch.**
    English sparrow.

(Although not a native of America, yet its increasing numbers and familiar habits bring it so prominently into view that to omit it would be unfair.)

CLASS II. Includes the true migrants or those birds in which the migratory instinct is so strong as to urge onward their movements regardless of weather or the food supply.

1. Turdus migratorius, L.
   Robin. (Breeds.)
2. Turdus fuscescens, Steph.
   Wilson's thrush.
3. Turdus unalascæ nanus, (Aud.) Coues.
   Hermit thrush.
4. Turdus ustulatus aliciæ, (Bd.) Coues.
   Alice's thrush.
5. Turdus ustulatus swainsoni, (Cab.) Coues.
   Olive backed thrush.
6. Mimus carolinensis, (L.) Gr.
   Cat bird. (Breeds.)
7. Harporhynchus rufus, (L.) Cab.
   Brown thrush. (Breeds.)
8. Sialia sialis, (L.) Hald.
   Blue bird. (Breeds.)
9. Regulus calendula, (L.) Licht.
   Ruby crowned kinglet.
10. Regulus satrapa, Licht.
    Golden crowned kinglet.

11. Troglodytes domesticus, (Bartr.) Coues.
House wren. (Breeds.)

12. Telmatodytes palustris, (Bartr.) Cab.
Long billed marsh wren. (Breeds.)

13. Cistothorus stellaris, (Licht.) Cab.
Short billed marsh wren. (Breeds in Outagamie Co.)

14. Anthus ludovic anus, (Gm.) Licht.
Titlark.

15. Mniotilta varia, (L.) V.
Black and white creeper. (Breeds.)

16. Parula americana, (L.) Bp.
Blue yellow-backed warbler. (Breeds.)

17. Helminthophaga chrysoptera, (L.) Bd.
Blue golden winged warbler. (Breeds.)

18. Helminthophaga ruficapilla, (Wils.) Bd.
Nashville warbler.

19. Helminthophaga celata, (Say) Bd.
Orange crowned warbler.

20. Helminthophaga peregrina, (Wils.) Cab.
Tennessee warbler.

21. Dendrœca aestiva, (Gm.) Bd.
Summer warbler. (Breeds.)

22. Dendrœca virens, (Gm.) Bd.
Black throated green warbler.

23. Dendrœca cærulescens, (L.) Bd.
Black throated blue warbler.

24. Dendrœca coronata, (L.) Gr.
Yellow rumped warbler.

25. Dendrœca blackburniæ, (Gm.) Bd.
Blackburn's warbler.

26. Dendrœca striata, (Forst.) Bd.
Black poll warbler.

27. Dendrœca castanea, (Wils.) Bd.
Autumnal warbler.

28. Dendrœca pennsylvanica, (L.) Bd.
Chestnut sided warbler. (Breeds.)

29. Dendrœca maculosa, (Gm.) Bd.
Black and yellow warbler.

30. Dendrœca tigrina, (Gm.) Bd.
Cape May warbler.

31. Dendrœca palmarum, (Gm.) Bd.
Yellow red poll warbler.

32. Dendrœca pinus, (Bartr.) Bd.
Pine creeping warbler.

33. Siurus auricapillus, (L.) Sw.
Golden crowned thrush. (Breeds.)

34. Siurus nævius, (Bodd.) Coues.
Water thrush. (Breeds.)

35. Geothlypis trichas, (L.) Cab.
Maryland yellow throat. (Breeds.)

36. Myiodioctes pusillus, (Wils.) Bp.
Green black capped warbler.

37. Myiodioctes canadensis, (L.) Aud.
Canadian fly catching warbler.

38. Setophaga ruticilla, (L.) Sw.
American redstart. (Breeds.)

39. Pyranga rubra, (L.) V.
Scarlet tanager. (Breeds.)

40. Hirundo erythrogastra horreorum, (Bartr.) Coues.
Barn swallow. (Breeds.)

41. Iridoprocne bicolor, (V.) Coues.
White bellied swallow. (Breeds.)

42. Petrochelidon lunifrons, (Say) Cab.
Eave swallow. (Breeds.)

43. Cotile riparia, (L.) Boie.
Bank swallow. (Breeds.)

44. Stelgidopteryx serripennis, (Aud) Bd.
Rough winged swallow. (Breeds Outagamie Co.)

45. Progne subis, (L.) Bd.
Purple marten. (Breeds.)

46. Ampelis cedrorum, (V.) Bd.
Cedar bird. (Breeds.)

47. Vireo olivaceus, (L.) V.
Red eyed greenlet. (Breeds.)

48. Viveo philadelphicus, Cass.
Brotherly love vireo.

49. Vireo gilvus, (V.) Bp.
Warbling vireo. (Breeds)

50. Vireo flavifrons, V.
Yellow throated vireo. (Breeds Outagamie Co)

51. Vireo solitarius, V.
    Blue headed vireo.

52. Lanius ludovicianus excubitorides, (Sw.) Coues.
    White rumped shrike. (Breeds.)

53. Passerculus sandvicensis savanna, (Wils.) Ridg.
    Savanna sparrow. (Breeds.)

54. Pocecetes gramineus, (Gm.) Bd.
    Grass finch. (Breeds.)

55. Melospiza lincolni, (Aud.) Bd.
    Lincoln's song sparrow.

56. Melospiza palustris (Bartr.) Bd.
    Swamp song sparrow. (Breeds).

57. Melospiza fasciata, (Gm.) Scott.
    Song sparrow. (Breeds.)

58. Spizella domestica, (Bartr.) Coues.
    Chipping sparrow. (Breeds.)

59. Zonotrichia albicollis, (Gm.) Bp.
    White-throated sparrow. (Breeds Outagamie Co.)

60. Zonotrichia leucophrys, (Forst.) Sw.
    White-browed sparrow.

61. Chondestes grammicus, (Say) Bp.
    Lark finch. (Breeds.)

62. Passerella iliaca, (Merr.) Sw.
    Fox colored sparrow.

63. Zamelodia ludoviciana, (L.) Coues.
    Rose breasted grosbeak. (Breeds.)

64. Passerina cyanea, (L.) Gray.
    Indigo bird. (Breeds.)

65. Pipilo erythrophthalmus, (L.) V.
    Chewink. (Breeds.)

66. Dolichonyx oryzivorus, (L.) Sw.
    Bobolink. (Breeds.)

67. Molothrus ater, (Bodd.) Gray.
    Cow bird. (Breeds.)

68. Xanthocephalus icterocephalus, (Bp.) Bd.
    Yellow headed blackbird.

69. Sturnella magna, (L.) Sw.
    Meadow lark. (Breeds.)

70. Icterus galbula, (L.) Coues.
    Baltimore oriole. (Breeds.)

71. Quiscalus purpureus, (Bartr.) Licht.
Purple grackle. (Breeds.)

72. Tyrannus carolinensis, (L.) Bd.
King bird. (Breeds.)

73. Myiarchus crinitus, (L.) Cab.
Great crested fly-catcher. (Breeds Outagamie Co.

74. Sayiornis fusca, (Gm.) Bd.
Phoebe. (Breeds.)

75. Contopus virens, (L.) Cab.
Wood pewee. (Breeds.)

76. Empidonax minimus, Bd.
Least fly-catcher. (Breeds.)

77. Empidonax flaviventris, Bd.
Yellow bellied fly-catcher.

78. Antrostomus vociferus, (Wils.) Bp.
Whip-poor-will. (Breeds.)

79. Chordediles popetue, (V.) Bd.
Night hawk. (Breeds.)

80. Chætura pelasgica, (L.) Steph.
Swift. (Breeds.)

81. Trochilus colubris, L.
Ruby throated hummer. (Breeds.)

82. Ceryle alcyon, (L.) Boie.
Kingfisher. (Breeds.)

83. Coccygus erythrophthalmus, (Wils.) Bd.
Black billed cuckoo. (Breeds.)

84. Coccygus americanus, (L.) Bp.
Yellow billed cuckoo. (Breeds.)

85. Sphyropicus varius, (L.) Bd.
Yellow bellied woodpecker. (Breeds.)

86. Melanerpes erythrocephalus, (L.) Sw.
Red headed woodpecker. (Breeds.)

87. Colaptes auratus, (L.) Sw.
Flicker. (Breeds.)

88. Asio wilsonianus, (Less.) Coues.
Long eared owl. (Breeds.)

89. Asio accipitrinus, (Pall.) Newt.
Short eared owl.

90. Circus cyaneus hudsonius, (L.) Coues.
Marsh hawk. (Breeds.)

91. Accipiter fuscus, (Gm.) Bp.
    Pigeon hawk.

92. Accipiter cooperi, Bp.
    Cooper's hawk. (Breeds.)

93. Falco columbarius, L.
    Pigeon falcon.

94. Falco sparverius, L.
    Sparrow hawk.

95. Buteo borealis, (Gm.) V.
    Hen hawk.

96. Ectopistes migratorius, (L.) Sw.
    Wild pigeon. (Breeds.)

97. Zenaidura carolinensis, (L.) Bp.
    Carolina dove. (Breeds.)

98. Squatarola helvetica, (L.) Cuv.
    Black bellied plover.

99. Charadrius dominicus, Müll.
    Golden plover.

100. Ægialites vociferus, (L.) Cass.
    Kildeer plover. (Breeds.)

101. Ægialites semipalmatus, (Bp) Cab.
    Ring neck plover.

102. Lobipes hyperboreus, (L.) Cuv.
    Northern phalarope.

103. Philohela minor, (Gm) Gr.
    Woodcock. (Breeds.)

104. Gallinago wilsoni, (Temm.) Bp.
    Wilson's snipe. (Breeds.)

105. Ereunetes pusillus, (L.) Cass.
    Semipalmated sandpiper.

106. Actodromas minutilla, (V.) Coues.
    Least sandpiper.

107. Actodromas bairdi, Coues.
    Baird's sandpiper.

108. Actodromas maculata, (V.) Coues.
    Jack snipe.

109. Pelidna alpina americana, (Cass.) Allen.
    Dunlin.

110. Symphemia semipalmata, (Gm.) Hartl.
    Willet.

111. Totanus melanoleucus, (Gm.) V.
Greater tattler.

112. Totanus flavipes, (Gm.) V.
Lesser tattler.

113. Rhyacophilus solitarius, (Wils.) Bp.
Solitary tattler. (Breeds Outagamie Co.)

114. Tringoides macularius. (L.) Gr.
Spotted sandpiper. (Breeds.)

115. Tryngites rufescens, (V.) Cab.
Buff breasted sandpiper.

116. Ardea herodias, L.
Great blue heron. (Breeds.)

117. Botaurus mugitans. (Bartr.) Coues.
Bittern. (Breeds.)

118. Rallus virginianus, L.
Virginia rail. (Breeds Outagamie Co.)

119. Porzana carolina, (L.) V.
Common rail. (Breeds.)

120. Anas boscas, L.
Mallard. (Breeds.)

121. Anas obscura, Gm.
Black mallard.

122. Dafila acuta, (L.) Jen.
Pintail. (Breeds Outagamie Co.)

123. Chaulelasmus streperus, (L.) Gr.
Gadwall.

124. Mareca americana, (Gm.) Steph.
Widgeon.

125. Querquedula carolinensis, (Gm.) Steph.
Green winged teal.

126. Querquedula discors, (L.) Steph.
Blue winged teal. (Breeds.)

127. Spatula clypeata, (L.) Boie.
Shoveler.

128. Aix sponsa. (L.) Boie.
Wood duck. (Breeds.)

129. Mergus merganser, L.
Merganser or fish duck.

130. Mergus serrator, L.
Red breasted merganser.

131. Mergus cucullatus, L.
Hooded merganser. (Breeds.)

132. Sterna hirundo, L.
Common tern.

133. Hydrochelidon lariformis, (L.) Coues.
Black tern.

134. Podicipes cornutus, (Gm.) Lath.
Horned grebe.

135. Podilymbus podiceps, (L.) Lawr.
Hell diver.

CLASS III. Birds that are migratory but whose movements through these counties seem greatly influenced by changes of temperature. A moderate variation in our winter would undoubtedly cause many individuals of these species to become "winter residents" in this locality.

1. Certhia familiaris, L.
Brown creeper. (Breeds.)

2. Sitta canadensis, L.
Red bellied nuthatch.

3. Eremophila alpestris, (L.) Boie. (var. praticola, Henshaw, 1884)
Horned lark. (Breeds.)

4. Lanius borealis, V.
Butcher bird.

5. Carpodacus purpureus, (Gm.) Gr.
Purple finch. (Breeds.)

6. Astragalinus tristis, (L.) Cab.
Yellow bird. (Breeds.)

7. Junco hiemalis, (L.) Scl.
Snow bird.

8. Spizella monticola, (Gm.) Bl.
Tree sparrow.

9. Agelæus phœniceus, (L.) V.
Red winged blackbird. (Breeds.)

10. Scolecophagus ferrugineus, (Gm.) Sw.
Rusty grackle.

11. Corvus frugivorus, Bartr.
Crow. (Breeds.)

12. Astur atricapillus, (Wils.) Bp.
    Goshawk.

13. Archibuteo lagopus sancti-johannis, (Gm.) Ridg.
    Rough-legged buzzard.

CLASS IV. Birds that are migratory, but whose movements, with those of Class III., are influenced to a great extent by immediate changes of temperature. In this class the southward movement is deterred until the freezing of our bays and rivers. Pot hunters for many seasons past have taken most of the following species, up to the very day of freezing up:

1. **Fulica americana, Gm.**
   Coot

2. **Chen hyperboreus, (Pall.) Boie.**
   Snow goose.

3. **Bernicla canadensis, (L.) Boie.**
   Canada goose.

4. **Haliaetus leucocephalus, (L.) Savig.**
   Bald eagle. (Breeds).

5. Bernicla canadensis hutchinsi, (Rich.) Coues.
   Hutchin's goose.

6. Fuligula marila, (L.) Steph.
   Greater black head.

7. Fuligula affinis, Eyt.
   Lesser black head.

8. Fuligula collaris, (Donov.) Bp.
   Ring neck duck. (Breeds Outagamie Co.)

9. Fuligula ferina americana, (Eyt.) Coues.
   Red head.

10. Fuligula vallisneria, (Wils.) Steph.
    Canvas back.

11. Clangula glaucium, (L.) Brehm.
    Golden eye. (Breeds Outagamie Co.)

12. Clangula albeola, (L.) Steph.
    Buffle head.

13. Harelda glacialis, (L.) Leach.
    Long tailed duck.

14. Œdemla americana, Sw.
    Black scoter.
15. Œdemia fusca, (L.) Flem.
    Velvet scoter.
16. Erismatura rubida, (Wils.) Bp.
    Ruddy duck.
17. Larus argentatus, Brünn.
    Herring gull.
18. Larus delawarensis, Ord.
    Ring billed gull.
19. Chroicocephalus philadelphia, (Ord.) Lawr.
    Bonaparte's gull.
20. Colymbus torquatus. Brünn.
    Loon.

CLASS V.—Birds from northern sections that visit us each fall. Some of the species remaining throughout the winter, others appearing irregularly during the colder months.

1. Anorthura troglodytes hiemalis, (Wils.). Coues.
   Winter wren. (A few breed in Outagamie Co.)
2. Ampelis garrulus, L.
   Bohemian waxwing.
3. Pinicola enucleator, (L.) V.
   Pine grosbeak.
4. Loxia leucoptera, Gm.
   Whi e winged crossbill.
5. Loxia curvirostra americana (Wils.) Coues.
   Common crossbill,
6. Ægiothus linaria, (L.) Cab.
   Red-poll linnet.
7, Chrysomitris pinus, (Bartr.) Bp.
   Pine linnet.
8. Plectrophanes nivalis, (L.) Meyer.
   Snow bunting.
9. Centrophanes lapponicus, (L.) Kaup.
   Lapland longspur.
10. Perisoreus canadensis, (L.) Bp.
    Canada jay.

11. Picoides arcticus, (Sm.) Gray.
    Black backed three-toed woodpecker.

12. Nyctea scandiaca, (L.) Newt.
    Snowy owl.

13. Nyctala acadica, (Gm.) Bp.
    Saw whet owl. (Breeds.)

CLASS VI. Birds whose visitations are so rare as to compel me to place them in my list either as a stray from other sections, or as one whose regular occurrences have escaped my notice.

1. Turdus mustelinus, Gm.
   Wood thrush.
   I have found but one pair of these birds in Brown county, and they were nesting; the nest contained three eggs.

2. Protonotaria citrea, (Gm.) Bd.
   Prothonotary warbler.
   A single specimen was taken May 4, 1883, by Mr. F. L. Grundtvig, at Shiocton.

3. Spizella agrestis, (Bartr.) Coues.
   Field sparrow.
   A southerly bird, taken in Brown Co. only a few times in 1882.

4. Junco hiemalis oregonus, (Towns.) Coues.
   Oregon snow bird.
   A specimen of Junco was taken in W. De Pere October 6th, 1883, the markings (identified by Coues) inclined strongly towards oregonus

5. Icterus spurius, (L.) Bp.
   Orchard oriole.
   Noticed but twice in Brown Co.

6. Hylotomus pileatus, (L.) Bd.
   Pileated woodpecker.
   Heavier timber seems to be all that is necessary to make this species a resident in Brown Co.

7. Pandion haliaetus, (L.) Sav.
   Fish hawk.
   Only occasionally seen in Brown Co.

8. Corvus corax, L.
   Raven.
   I have taken but one specimen in Brown Co.

9. Centurus carolinus, (L.) Bp.
   Red bellied woodpecker.
   A rare spring visitor.

10. Cathartes aura, (L.) Ill.
   Turkey buzzard.
   None seen in Brown Co., a few were noticed by Mr. F. L. Grundtvig in Outagamie Co.

11. Ortyx virginiana, (L.) Bp.
   Quail.
   I have not met this species in Brown Co., although Louis Sheller, Green Bay, has a mounted specimen which he claims to have taken here.

12. Strepsilas interpres, (L.) Ill.
   Turnstone.
   June 2, '82, a flock of 5 of these birds were seen near West De Pere, 3 were taken.

13. Limosa fœda, (L.) Ord.
   Marbled godwit.
   Louis Scheller reports having taken this species near Green Bay I have not found it.

14. Bartramia longicauda, (Bechst.) Coues.
   Field plover.
   May 1st '82, a single specimen was taken by Harry Hammond in West De Pere.

15. Butorides virescens, (L.) Cab.
   Green heron.
   Mr. F. L. Grundtvig saw a single specimen near Shiocton, Outagamie Co.

16. Ardetta exilis, (Gm.) Gr.
   Least bittern.
   May 20th '83, a male of this species was taken near West De Pere.

17. Gallinula galeata, (Licht.) Bp.
   Florida gallinule.
   Subsequent observation (1884) warrants the insertion of this species in Class II.

18. Chen hyperboreus albatus, (Cass.) Ridg.
   Lesser snow goose.
   April 22d '81, a single specimen was taken on the shore of Fox River near De Pere.

Summing up the above six classes, I find the avian fauna of Brown and Outagamie counties, to consist of two-hundred

and ten species. Eleven are residents throughout the year. Eighteen are strays or very rare visitors. Eighty-seven are summer residents, and ninety-four are through migrants. Of the above residents and migrants, one-hundred species have been known to breed in either Brown or Outagamie counties.

In the following table, I have attempted to compare the arrival of our migratory birds, for the years 1882 and 1883; giving as data, the results of Mr. F. L. Grundtvigs's observations at Shiocton, and mine at West De Pere.

Great value should especially be placed upon the observations of Mr. F. L. Grundtvig, while at Shiocton, for during these observations, his whole time was constantly devoted to the work. The collecting trips, usually made twice each day, took him through varied places, on both land and water.

Each arrival was recorded after personal observation and careful study. Few species escaped his notice, and no arrival to my knowledge, was omitted from his daily record.

Care should be exercised in using my notes with his. Although I have been very careful to record each arrival, and note every fact of interst respecting our birds, yet, owing to the many hurried trips that I was obliged to take, arrivals of the more shy and retiring species unquestionably escaped my notice, until increasing numbers made them more conspicuous. At times, a day or so would pass without the customary tramp; but afterwards, I was slow to record any species, whose abundance indicated that they had arrived during my absence. This partly explains a number of the instances where "A" in the following table has been placed among the Brown County arrivals.

ARRIVAL OF MIGRANTS IN BROWN AND OUTAGAMIE COUNTIES CONSECUTIVELY COMPARED FOR THE YEARS 1882 AND 1883.

	First Arrivals, Outagamie Co., 1882.	First Arrivals. Brown Co., 1882.	First Arrivals, Outagamie Co., 1883.	First Arrivals, Brown Co., 1883.
Turdus migratorius	Feb. 26	Mar. 10	Mar. 22	Mar. 26
Turdus fuscescens	May 10	May 8	May 22	A.*
Turdus unalascæ nanus	April 10	April 22	April 22	April 5
Turdus ustulatus swainsoni	May 10	B†	B.	B.
Mimus carolinensis	May 9	May 14	May 8	May 14
Harporhynchus rufus	May 7	May 18	B.	April 11
Sialia sialis	Mar. 3	Mar. 14	Mar. 29	Mar. 29
Regulus calendula	April 10	April 14	April 11	April 10
Regulus satrapa	April 9	April 3	April 9	April 5
Certhia familiaris	Mar. 28	April 6	Mar. 20	April 9
Troglodytes domesticus	May 5	May 13	May 7	May 12
Telmatodytes palustris	May 30	A.	A.	B.
Cistothorus stellaris	May 18	B.	A.	B.
Anthus ludovicianus	May 20	B.	B.	B.
Mniotilta varia	May 1	May 10	May 6	May 14
Parula americana	May 3	A.	May 7	May 23
Helminthophaga chrysoptera	May 15	May. 10	May 19	May 15
Helminthophaga ruficapilla	May 4	May 8	May 7	B.
Helminthophaga celata	April 30	B.	May 1	B.
Helminthophaga peregrina	May 19	A.	May 22	May 21
Dendroeca aestiva	May 3	May 10	May 7	A.
Dendrœca virens	May 4	May 10	May 7	A.
Dendrœca caerulescens	May 8	B.	May 12	May 15
Dendrœca coronata	April 5	April 6	April 12	April 9
Dendrœca blackburniae	May 3	May 10	May 7	May 15
Dendrœca striata	May 10	A.	May 18	May 19
Dendrœca castanea	May 18	May 8	May 20	A.
Dendrœca pennsylvanica	May 3	May 10	May 8	A.
Dendrœca maculosa	May 3	A.	May 14	A.
Dendrœca tigrina	May 8	May 9	May 7	May 15
Dendrœca palmarum	May 1	A.	May 7	B.
Dendrœca pinus	May 3	April 21	April 24	May 15
Siurus auricapillus	May 9	May 8	May 9	May 15
Siurus naevius	April 26	A.	April 30	A.
Geothlypis trichas	May 10	May 31	May 10	A.
Myiodioctes pusillus	May 12	May 18	May 18	May 31
Myiodioctes canadensis	May 10	A.	May 18	B.
Setophaga ruticilla	May 3	May 10	May 7	May 15
Pyranga rubra	May 10	May 18	May 22	May 20
Hirundo erythrogastra horreorum	April 29	May 15	May 7	May 10
Iridoprocne bicolor	Mar. 29	April 1	April 7	May 7

* "A." Through neglect or omission the dates of the first arrivals were not recorded.
† "B." This species not noticed in the spring of that year.

ARRIVAL OF MIGRANTS IN BROWN AND OUTAGAMIE COUNTIES, ETC.—Continued.

	First arrivals, Outagamie Co., 1882.	First arrivals, Brown Co., 1882.	First arrivals, Outagamie Co., 1883.	First arrivals, Brown Co., 1883.
Petrochelidon lunifrons	April 25	April 21	April 29	May 10
Cotile riparia	May 12	B.	B.	B.
Stelgidopteryx serripennis	April 24	May 14	A.	May 21
Progne subis	April 10	April 16	A.	A.
Ampelis cedrorum	May 19	June 5	A.	A.
Vireo olivaceus	May 11	May 22	May 18	May 26
Vireo philadelphicus	May 23	May 31	B.	B.
Vireo gilvus	May 9	A.	May 8	A.
Vireo flavifrons	May 8	May 26	May 5	May 14
Vireo solitarius	B.	May 18	May 7	B.
Lanius ludovicianus excubitorides	A.	A.	A.	April 8
Carpodacus purpureus	Mar. 5	April 14	April 9	Mar. 14
Passerculus sandvicensis savana	A.	A.	April 26	April 28
Pocecetes gramineus	April 14	April 14	April 9	April 9
Melospiza lincolni	May 20	B.	B.	B.
Melospiza palustris	.....	.....	.....	.....
Melospiza fasciata	Mar. 29	Mar. 28	April 6	April 6
Spizella domestica	April 20	April 19	April 12	April 18
Zonotrichia albicollis	April 25	May 8	April 22	A.
Zonotricha leucophrys	May 13	A.	May 12	May 14
Chondestes grammicus	B.	May 3	B.	May 5
Passerella iliaca	April 13	April 21	April 9	April 11
Zamelodia ludoviciana	May 9	A.	May 16	May 23
Passerina cyanea	May 18	May 17	May 22	May 25
Pipilo erythrophthalmus	April 26	April 21	April 26	April 11
Dolichonyx oryzivorus	May 17	A.	May 15	May 15
Molothrus ater	April 17	April 14	May 3	April 11
Xanthocephalus icterocephalus	May 30	B.	B.	B.
Sturnella magna	Mar. 28	Mar. 28	April 2	April 6
Icterus galbula	May 4	May 5	May 7	May 13
Quiscalus purpureus	Mar. 29	April 3	April 6	April 8
Tyrannus carolinensis	May 8	April 12	May 7	May 14
Myiarchus crinitus	May 14	B.	May 7	B.
Sayiornis fusca	April 2	Mar. 29	April 6	April 8
Contopus virens	May 20	A.	May 26	A.
Empidonax minimus	May 5	A.	May 7	May 10
Empidonax flaviventris	May 18	A.	May 22	B.
Antrostomus vociferus	April 28	A.	April 26	A.
Chordediles popetue	May 19	A.	May 1	A.
Chætura pelasgica	May 9	April 1	May 7	May 10
Trochilus colubris	May 9	May 20	May 17	A.
Ceryle alcyon	April 1	April 9	April 9	April 11
Coccygus erythrophthalmus	May 18	May 20	May 25	B.
Sphyropicus varius	Mar. 27	April 7	April 9	April 7
Melanerpes erythrocephalus	May 12	April 3	May 8	May 15
Colaptes auratus	April 1	April 3	April 9	April 12

Believing that there exists certain relations between the dietetic habits of our true migrants and their order of arrival, I have prepared the following annotated list. I have chosen the order in which they arrived in the spring of 1882, as my observations then were more thorough than in 1883:

Turdus migratorius. (Robin.) Mch. 10.
Its principal food consists of worms, caterpillars and berries.*

Sialia sialis. (Blue bird.) Mch. 14.
Food — Larvæ and insects.

Sturnella magna. (Meadow lark.) Mch. 28.
Food — Larvæ and insects.

Melospiza fasciata. (Song sparrow.) Mch. 28.
Food — Seeds and insects.

Sayiornis fusca. (Phœbe.) Mch. 29.
A purely insectivorous bird.

Iridoprocure bicolor. (White bellied swallow.) Apr. 1.
Also an insectivorous bird.

Quiscalus purpureus. (Purple grackle.) Apr. 3.
In the spring its food is mostly worms, grubs and caterpillars.

Regulus satrapa. (Golden crowned kinglet.) Apr. 3.
Food — Small insects and larvæ.

Colaptes auratus. (Flicker.) Apr. 3.
Food — Ants, beetles and caterpillars.

Certhia familiaris. (Brown creeper.) Apr. 6.
Food — Small beetles and insects.

Dendrœca coronata. (Yellow rump warbler.) Apr. 6.
Food — Caterpillars, small flies and beetles.

Sphyropicus varius. (Yellow bellied wood-pecker.) Apr. 7.
Food — Ants, beetles and small insects.

Tyrannus carolinensis. (King bird.) Apr. 12.
Food is wholly insectivorous.

Regulus calendula. (Ruby crowned kinglet.) Apr. 14.
Food — Larvæ and small insects.

Carpodacus purpureus. (Purple finch.) Apr. 14.
Food — Seeds, buds, plant-lice and caterpillars.

---

* The notes respecting the food were mostly taken from Prof. F. H. King's work, entitled "The Economic Relations of Wisconsin Birds," published in "Geology of Wisconsin," Vol. I.

Pocecetes gramineus. (Grass finch.) Apr. 14.
Food — Seeds and insects.

Molothrus ater. (Cow bird.) Apr. 14.
Food is chiefly insects.

Progne subis. (Purple marten.) Apr. 16.
Food wholly insectivorous.

Spizella domestica. (Chipping sparrow.) Apr. 19.
Food — Seeds, worms and insects.

Petrochelidon lunifrons. (Eave swallow.) Apr. 21.
Food wholly insectivorous.

Passerella iliaca. (Fox sparrow.) Apr. 21.
Food — Seeds, bugs and insects.

Pipilo erythrophthalmus. (Chewink.) Apr. 21,
Food — Seeds, insects and worms,

Turdus unalascæ nanus. (Hermit thrush.) Apr. 22.
Food — Ants, beetles and caterpillars.

The seed eaters as will be seen by this list, do not appear to arrive in force, until some time after the insect eaters have made their appearance. This is quite contrary to some existing ideas now held by some naturalists respecting these movements. But why these birds are not among the very first, appears to me a singular anomaly. In their case, the temperature must be an important agent in influencing their movements, for their food, the seeds, are as easily obtained in the earlier months, as in May or June, no new plants having had time to flower before their arrival.

While the food of a few of the earlier migrants consists chiefly of winged insects, yet the majority of the first comers subsist upon grubs, caterpillars and worms, that are largely found in crevices in the bark of trees, under fallen limbs, on old rails, and in many other similar places. Unless these birds are gifted with the art of discovering larvæ and insects while in their winter quarters, the awakening of articulate life must be an important factor in affecting these migrations.

Mr. F. L. Grundtvig when pursuing his close observations discovered that the yellow rumps (Dendrœca coronata) when they first arrived, associated more or less with the woodpeckers, and like them were successful in obtaining con-

cealed larvæ and small insects from under the edges of the shaggy bark. They were seen to frequent the terminal branches, and seek their food amidst the starting foliage, after the only throng of their brother warblers began to arrive and winge insects were becoming numerous.

This matter of being able to obtain sufficient insect food in various ways, must give this warbler an advantage over its allies, which I think may possibly account for its immense numbers as compared with some of the other species.

Does not this rule apply to other birds as well, and in part explain the reason why our earlier species are among our *most abundant* birds?

Birds in districts of homogeneous characters are restricted to certain areas by isotherms, but in country not entirely suitable for certain representative species, would not the isotherm be only a minor consideration as affecting their distribution ?

Can we properly judge of the extent of the faunal areas in any specified section, until the whole section is practically inhabitable for them during the warmer months ? In other words, as civilization progresses and timbered districts and swampy tracts become converted into meadows and farming lands, may not the avian fauna of an adjoining southern district extend northward until checked by the isotherm that constitutes the actual boundary of these divisions ? Brown County at the lower terminus of the Fox River Valley is the last of a series of counties connecting with the warmer sections of sonthern Wisconsin and northern Illinois, that are throughout habitable for such birds as prefer meadows and cultivated fields.

As single field sparrows, orchard orioles, and wood thrushes are found heré only at irregular intervals, must we not feel confident of the close proximity of the northern limit of the Alleghanian fauna, of which they are representative members ?

Shiocton, Outagamie Co., the place of Mr. F. L. Grundtvig's diligent and thorough observations is almost directly west from us at De Pere, yet notwithstanding this, he has never on any of his varied excursions found the lark finch,

field sparrow or orchard oriole. Around Shiocton there are farms and some meadow lands but they are isolated. For miles on either side extends a tract of worthless land, once a forest, but now transformed by destructive fires into an impenetrable non-productive area. The banks of the Wolf River are at present wholly covered with green timber which is well adapted for arboreous species, but not for those referred to above. With these considerations in mind I believe that the northern limit of the Alleghanian fauna in eastern Wisconsin is not far from the southern boundary of Marinette County or where it meets the waters on the western shore of Green Bay.

THE VARIATION IN ATTRACTION DUE TO THE FIGURE OF THE ATTRACTING BODIES.

By D. P. BLACKSTONE, A. M., C. E., Berlin, Wis.

INTRODUCTION.

1. This paper is a part of the investigations that I have nearly completed on the subject, *The Variation in Figure and in Attraction of a once Fluid Body, due to Rotation, Law of Density, and Contraction.* The portion of the investigations on that subject pertaining to attraction, herein given, is abbreviated by the omission of some of the mathematical demonstrations, and some evident deductions. The results attained by my method give numerical exactness to any power of the eccentricity of the ellipsoid.

This paper develops by geometrical methods the law of attraction for spheres, each of homogeneous mass, or each or either composed of fluid masses of heterogeneous densities. It also develops by the same methods the variation in attraction due to ellipsoidal figure, where one of the attracting bodies is an ellipsoid of homogeneous mass, the standard for measuring the variation being the attraction of the mass of the ellipsoid condensed at its own center.

A part of my investigation on attraction, not herein given, develops the variation in attraction due to ellipsoidal figure where the ellipsoid is composed of fluid masses of heterogeneous densities. In this paper I take it as granted that a fluid mass under the law of the mutual attraction of its own component particles, takes on the form of an oblate ellipsoid. In my investigation pertaining to fluid equilibrium I demonstrate under what conditions of rotation the fluid mass assumes the form of an oblate ellipsoid, and also under what conditions of rotation the fluid mass has not defined mathematical figure, but would go back if expanded by heat, to nebula, "without form and void."

In finding the attraction of an ellipsoid on any outside particle or body I avoid the use of the expedient of

confocal ellipsoids. In case, however, the outside particle is in the plane of the equator or line of the poles, it is an evident inference from my investigation that two confocal ellipsoids having their foci at the same points, attract the same particle outside of both, as their masses. In case the outside particle is otherwise located, I have a short and simple demonstration which, if put in at the end of Art. 18 of this paper, would prove that confocal ellipsoids attract any outside particle, as their masses. Todhunter in the second volume of his *History of the Theories of Attraction and the Figure of the Earth,* says, referring to the expedient of confocal ellipsoids: "Legendre we see arrived at his theorem incidentally as he was developing a new demonstration of Laplace's theorem; and the improvement subsequently effected by Ivory in the treatment of Laplace's theorem has probably much diminished the interest which would otherwise have continued to belong to Legendre's. Nevertheless it is to be wished that a simple investigation could be supplied of the remarkable result; and perhaps this may be attained in consequence of thus drawing attention to it."

It is true that the final results of the investigation of this paper reduce to the same as those well known by mathematicians. It is also doubtless true that the modern method of the Calculus is the best for obtaining a specific conclusion. But it seems to me that a new and true geometrical investigation on an intricate subject like this, must furnish another lamp by which can be seen new deductive truths. However this may be, I feel well compensated for the brain force expended in the general mental culture received, and especially in a sharpened ability to detect the fallacious logic in my own scientific and philosophic thought.

2. Two particles at a sensible distance apart attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of their distance. This law is accepted because it is the only law of attraction that accords with physical phenomena.

INVESTIGATION.

I.

SPHERICAL ATTRACTION.

It is proved under Heading I. by demonstration and deduction:

First.—That two homogeneous spheres, or two spheres, each made up in laminæ varying in densities from lamina to lamina, attract each other directly as product of masses, and inversely as square of distance from center to center.

Second.—That a mass composed of fluids under the law of the mutual attraction of component particles, arranges itself, in order of the densities of the fluids, in a sphere made up in laminæ with the most dense at the center.

3. To find the resultant attraction of an assemblage of particles constituting a homogenous sphere on an outside particle.

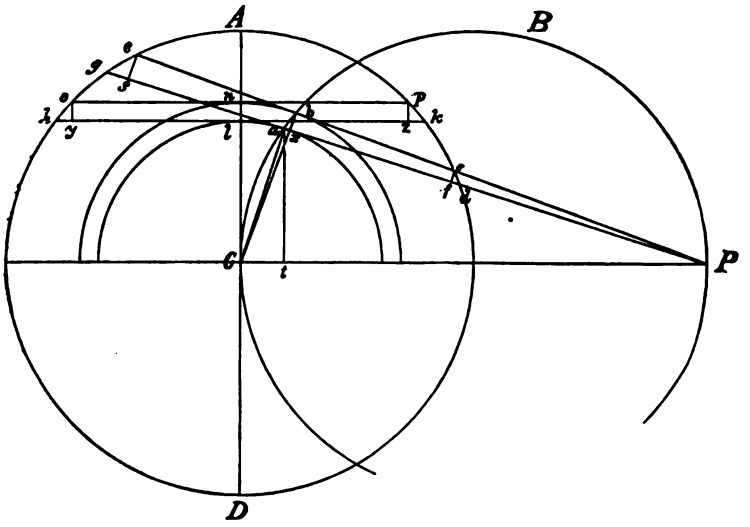


Diagram 1.

In Diagram 1 let C be the center of the sphere, having radius C A, and P the attracted particle. Also let C B P be a circle described on C P as diameter, From P draw any two lines, P g and P e cutting the sphere; also cutting the circumference C B P in points a and b, making the angle g P e infinitesimal. On the radius C A perpendicular to P C, take C l equal to chord C a, and C n equal to C b. Through l and n draw chords h k and o p, parallel to C P. Then chord h k equals chord g d, and o p equals e c. Per law of ultimate ratio when the angle e P g becomes infin-

itesimal, the point x of intersection of chord g d with C b coincides with point a, and a b equals l n.

Draw t a perpendicular to P C. Then angle C P a equals t a C. Let this angle be represented by ϑ. Then is circumference or length of arc generated by point l rotated on axis P C for one rotation or an infinitesimal part of a rotation to circumference or length of arc generated by point a so rotated, as unity to cosine ϑ.

Divide the equal chords g d and h k each into the same number of equal and infinitesimal parts, and from the points of division draw lines as s e, f c, etc., parallel to C a, and y o, z p, etc., parallel to C A. Then for one or an infinitesimal part of a rotation, the volumes generated by surfaces having dimensions a b, s e, f c, etc., each into an equal and infinitesimal division of length along g d, are directly proportional to squares of distances P a, P s, P f, etc. In case then of a sphere of homogeneous density each division along chord g d has a mass directly proportional to the square of its distance from P. Therefore per law of attraction for particles *directly as mass and inversely as square of distance*, the attraction of the mass at any division along chord g d, on particle P is the same as that at division a. The attraction then, in direction P a of whole mass between chords e c and g d, is equal to that of mass at division a into the number of divisions of chord g d into inverse square of distance P a.

Let mass of sphere between chords op and h k rotated be represented by m. Then because h k equals g d, and l n equals a b, and because circumference of point l to circumference of point a rotated is as unity to cosine ϑ, mass of division a into chord g d equals $m \cos \vartheta$. In right angled triangle Pa C let hypotheneus P C be represented by D. Then side Pa equals $D \cos. \vartheta$.

$$\text{Attraction of mass } (m \cos \vartheta) \text{ on P in direction Pa} = \frac{m \cos \vartheta}{D^2 \cos^2 \vartheta}$$

$$\text{Attraction of mass } (m \cos \vartheta) \text{ on P in direction P C} = \frac{m \cos^2 \vartheta}{D^2 \cos^2 \vartheta} = \frac{m}{D^2}$$

But $\frac{m}{D^2}$ equals the attraction of a mass (m) condensed to the size of a particle at the center of the sphere on particle P.

Because P C is the axis ot rotation of chords e c and g d, particle P must be attracted in direction P C, and with a force equal to the attraction of the mass cut from the sphere by one rotation of the chords o p and h k, condensed at the center of the sphere.

As n l is any part of the radius A C the whole of a homogeneous sphere attracts an outside particle the same as the mass of the sphere condensed to its center.

4. A spherical shell is a sphere less a sphere of smaller radius. In accordance then, with investigation of Art. 3, a spherical shell attracts an outside particle the same as the mass of the shell condensed at its center.

5. A sphere made up of laminae varying in density from lamina to lamina is the same as a sphere composed of shells having densities corresponding to the laminae. The sphere, then, made up of laminae attracts an outside particle in conformity with the law for spherical shells or a homogeneous sphere.

6. When attracting sphere is condensed to a particle, the investigation of Art. 3 applies to the case where attracted particle P becomes a sphere. Two spheres, therefore, attract each other with a force directly as product of masses and inversely as square of distance from center to center.

7. To find the attraction of a sphere on a particle placed within it.

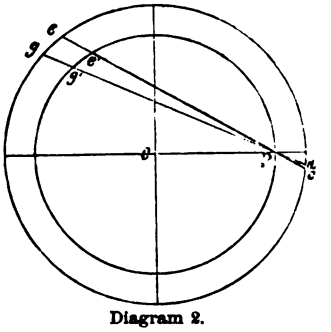


Diagram 2.

Diagram 2 shows particle P within the sphere. It is evident from investigation of Art. 3 that that portion of the sphere outside of the radius distance C P attracts particle P equally in opposite directions. The only uncounterbalanced attraction, then, on particle P is the attraction of that portion of the sphere inside of radius distance C P. Homogeneous spheres of same density vary in masses as cubes of radii. The attraction on particles inside of a homogeneous sphere vary, then, as their distances from the center of the sphere.

8. When the sphere is fluid and particle P becomes a small solid of less density than the sphere, then body P placed at the surface of the sphere floats, and when body P is more dense than the sphere at the surface it sinks. Its place of equilibrium is at the center of the sphere, in case all the laminae of the sphere are less dense than the body P, otherwise in a lamina having the same density as body P.

It is evident that the law of equilibrium requires a fluid mass acted on only by the force of the mutual attraction of component particles to assume a spherical figure, and in case the mass is composed of fluids of varying densities the fluids must take positions in spherical laminae in order of densities, with the most dense at the center.

II.

Preliminary Demonstrations Developing required New Expressions Pertaining to the Ellipse.

First: $A_{,} = B\sqrt{1+E_{,}^2 \cos^2 \vartheta} = A\sqrt{1-E^2 \sin^2 \vartheta}$

$B_{,} = B\sqrt{1+E_{,}^2 \sin^2 \vartheta} = A\sqrt{1-E^2 \cos^2 \vartheta}.$

Second: $\sin^2 \alpha = \dfrac{E^4 \sin^2 \vartheta \cos^2 \vartheta}{1-E^2+E^4 \sin^2 \vartheta \cos^2 \vartheta}$

In the above expressions A and B represent the semi-major and semi-minor axes of the ellipse, $A_{,}$ any semi-diameter and $B_{,}$ its semi-conjuegate. E^2 equals $\frac{A^2-B^2}{A^2}$ and $E_{,}^2$ equals $\frac{A^2-B^2}{B^2}$. Angle α is the difference between the angle made by any diameter with its conjugate and a right angle. ϑ is further on defined.

9. *To find any diameter and its conjugate, the major and minor axes of the ellipse being given.*

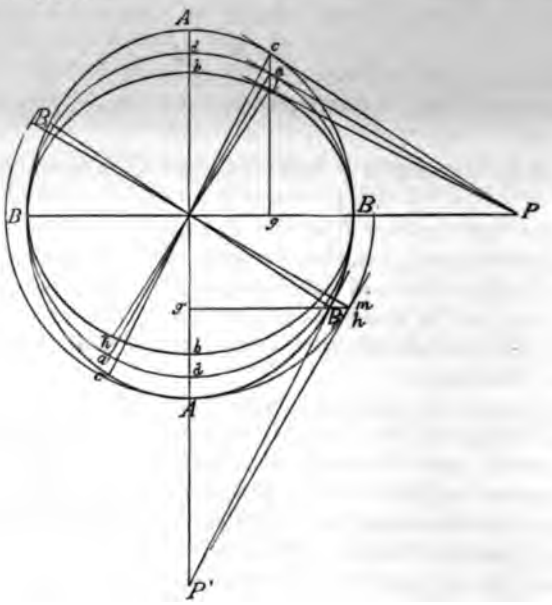


Diagram 3.

In Diagram 3* let A B A B be an ellipse having major axis A A and minor axis B B, and let B b B b be a second ellipse having B B major axis and similar in construction to first ellipse; also let B dB d be a circle with radius B C.

*** In center of Diagram 3 C is left out.**

Draw the tangent lines P c, P a and P l. Through the points of tangency c, a, l draw line c g so that the part l g is perpendicular to P C. Then by known demonstration of *conic sections* the line c g is straight, and g a is to g c as B to A, also g a is to g l as A to B. Since triangles l P g, a P g, and c P g have each a right angle at g and same base P g, the tangents of the angles l P g, a P g, and c P g are directly as g l, g a, and g c. Since the right angled triangles C l g, C a g, and C c g have the same perpendicular C g, the tangents of the angles C l g, C a g, and C c g are inversely as g l, g a, and g c. But angle a P g equals C a g. therefore angle l P g equals C c g, and angle c P g equals C l g. Also angle c P a equals a C l, and angle a P l equals c C a, and line C l produced is perpendicular to tangent line P c.

Produce major axis A A to P′, making distance C P′ to C P as A to B. Draw P′m tangent to circle having radius Cm equal to C A, and draw P′ $B_{,}$ tangent to ellipse having axes A A and B B. Through points of tangency m and $B_{,}$ draw m g′. m g′ is perpendicular to P′ C and parallel to P C. By constructions angle m P′ C equals a P C or C a g. Because then m g′ is to $B_{,}$ g′ inversely as A to B, angle C $B_{,}$ g′ equals c P g. Therefore $B_{,}$ C or $B_{,}$ $B_{,}$ is parallel to tangent line P c, and $B_{,}$ $B_{,}$ is a conjugate diameter to C $C_{,}$. The angle c C $B_{,}$ is greater or less than a right angle by the angle c C l or α.

Let angle C a g be represented by ϑ, C c g by $\vartheta - z$, and C l g by $\vartheta + y$. Hereafter in this investigation ϑ, or the angle in any ellipse in the situation of ϑ, is called the Elliptic Angle, $(\vartheta - z)$ is called the Alpha Elliptic, and $(\vartheta + y)$, the Beta Elliptic Angle.

It is now evident that:

$$Cg = B \sin \vartheta.$$

$$Cg' = A \sin \vartheta.$$

$$ag = B \cos \vartheta.$$

$$cg = \frac{A}{B} B \cos \vartheta = A \cos \vartheta.$$

$$mg' = A \cos \vartheta.$$

$$B_{,} g' = \frac{B}{A} A \cos \vartheta = B \cos \vartheta.$$

In right angled triangle C c g;

$$C c = A_{,} = \sqrt{A^2 \cos^2 \vartheta + B^2 \sin^2 \vartheta} = \sqrt{B^2 + (A^2 - B^2) \cos^2 \vartheta} =$$

$$\sqrt{A^2 - (A^2 - B^2) \sin^2 \vartheta}.$$

$$A_{,} = B \sqrt{1 + E_{,} \cos^2 \vartheta} = A \sqrt{1 - E^2 \sin^2 \vartheta}.$$

Likewise from right angled triangle C $B_{,}$ g′,

$$B_{,} = B \sqrt{1 + E_{,}^2 \sin^2 \vartheta} = A \sqrt{1 - E^2 \cos^2 \vartheta}.$$

10. *To find an expression for sine square of angle* α.

In triangle c C l,

$$\sin \alpha = \frac{\sin (\vartheta + y)\, \overline{c\,l}}{A_{,}}$$

$$c\,l = A \cos \vartheta - \frac{B^2 \cos \vartheta}{A} = A\, E^2 \cos \vartheta.$$

$$\sin (\vartheta + y) = \frac{A \sin \vartheta}{B_{,}}$$

$$\sin^2 \alpha = \frac{A^4\, E^4 \sin^2 \vartheta \cos^2 \vartheta}{A_{,}^2\, B_{,}^2} = \frac{E^4 \sin^2 \vartheta \cos^2 \vartheta}{(1 - E^2 \sin^2 \vartheta)(1 - E^2 \cos^2 \vartheta)}$$

$$\sin^2 \alpha = \frac{E^4 \sin^2 \vartheta \cos^2 \vartheta}{1 - E^2 + E^4 \sin^2 \vartheta \cos^2 \vartheta}$$

III.

OUTSIDE ELLIPSOIDAL ATTRACTION IN LINE OF POLES.

First.—An oblate Ellipsoid and an outside particle in line of the poles attract each other directly as product of mass of particle into mass of Ellipsoid multiplied by $(1 - \frac{3}{5} n^2 E_{,}^2 + \frac{3}{7} n^4 E_{,}^4 - \frac{3}{9} n^6 E_{,}^6 + \text{etc.})$ *and inversely as square of distance from center of ellipsoid to particle.**

Second.—A prolate ellipsoid and an outside particle in line of the poles attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $(1 + \frac{3}{5} n^2 E^2 + \frac{3}{7} n^4 E^4 + \frac{3}{9} n^6 E^6 + \text{etc.})$ *and inversely as square of distance.*

In the first case n equals the minor axis of the ellipsoid divided by the distance and in the second, the major axis divided by distance, $E_{,}^2$ equals E^2 divided by $(1 - E^2)$.

11. To find the attraction of an ellipsoid of rotation on an outside particle in line of axis of rotation.

In Diagram 4 let C be the center of the ellipsoid having major axis A A and minor axis B B, and let P be the attracted particle.

On P C as minor axis described a semi ellipse, similar to the one having C for its center. Also with C as the center and n C and l C as semi major axes describe two semi ellipses similar to ones already de-

---

*When not otherwise mentioned the ellipsoid is homogeneous. The word particle here used represents finite mass condensed to the dimensions of a particle.

scribed. The construction of the remaining portions of the diagram where not evident is explained.

Draw $B_{,}$ $B_{,}$ parallel to P a, and draw $A_{,}$ $A_{,}$ through point of tangency a and center C. $A_{,}$ $A_{,}$ and $B_{,}$ $B_{,}$ are, then, conjugate diameters.

Ordinate a d equals ordinate a g, l k equals l h. Per known demonstration of *Conic Sections;*

(*a*) $g\,d : h\,k :: B_{,} : B$.

When the angle e P g becomes infinitesimal, $A_{,}$ $A_{,}$ passes through the points of tangency a and b. From the similarity of the ellipses having C l, C n, and C A for semi major axes; $b\,a : n\,l :: A_{,} : A$. Draw s x through point a, and perpendicular to P a. Then $s\,a = b\,a \cos \alpha$

(*b*) $s\,a : n\,l :: A_{,} \cos. \alpha : A$.

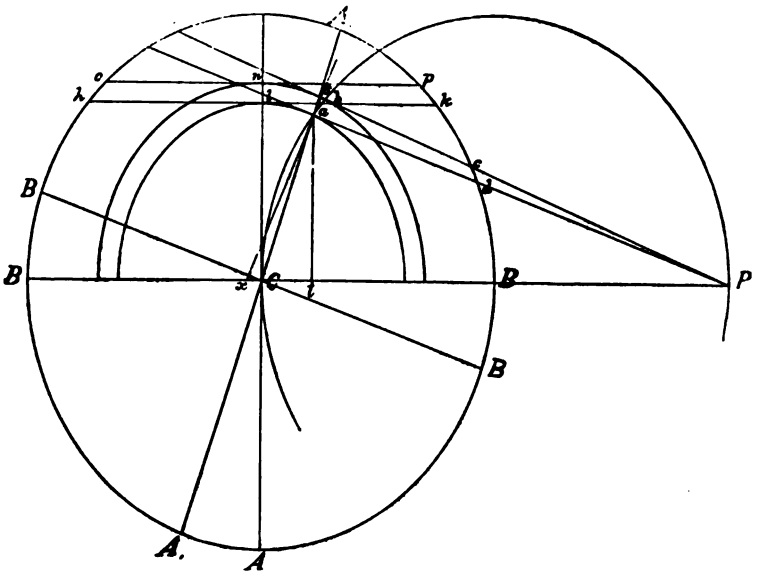


Diagram 4.

Draw t a perpendicular to P C. Per Art. 9, $t\,a = C\,l \cos. \vartheta$. Then from the similarity of the ellipses;

(*c*) $t\,a : C\,l :: A \cos. \vartheta : A$.

The product of the proportions (a) (b) (c) gives;

$g\,d \times s\,a \times t\,a : h\,k \times n\,l \times C\,l :: A\,A_{,}\,B_{,} \cos \vartheta \cos \alpha : A^2\,B :: \cos \vartheta : 1$.

The last ratio is true because $A_{,}\,B_{,} \cos \alpha = A\,B$.

In accordance with a demonstration in Art. 3, $g\,d \times s\,a \times t\,a$ represents a mass at point a, that attracts particle P in direction P a the same as the mass cut from the ellipsoid by rotating chords e c and g d on axis P C; and $h\,k \times n\,l \times C\,l$ represents a mass (m) from likewise rotating chords o p and h k.

Angle C a P equals $(90^\circ - \alpha)$, and angle a C P equals $90^\circ - (\vartheta - z)$. Let C P equal D. Then in triangle C a P, $Pa = D \frac{\cos(\vartheta - z)}{\cos \alpha}$.

Attraction of mass $(m \cos \vartheta)$ in direction Pa on $P = \frac{m \cos \vartheta \cos^2 \alpha}{D^2 \cos^2 (\vartheta - z)}$

Attraction of mass in direction $PC = \frac{m \cos \vartheta \cos(\vartheta + y) \cos^2 \alpha}{D^2 \cos^2 (\vartheta - z)}$

In triangle C c g, Diagram 3.

$$\cos(\vartheta - z) = \frac{A \cos \vartheta}{A_{,}}$$

In triangle C $B_{,}$ g, Diagram 3.

$$\cos(\vartheta + y) = \frac{B \cos \vartheta}{B_{,}}$$

$$\text{Attraction, etc.,} = \frac{M}{D^2} \times \frac{A_{,}^2 B \cos^2 \alpha}{A^2 B_{,}}$$

$$A_{,}^2 B_{,}^2 \cos^2 \alpha = A^2 B^2, \text{ or } \frac{A_{,}^2}{A^2} = \frac{B^2}{B_{,}^2 \cos^2 \alpha}$$

In case then of an oblate ellipsoid,

Attraction of mass $(m \cos \vartheta)$ in direction P C on $P = \frac{m}{D^2} \times \frac{B^2}{B_{,}^2}$

Likewise for a prolate ellipsoid,

Attraction of mass $(m' \cos \vartheta)$ etc., $= \frac{m'}{D_{,}^2} \times \frac{A^3}{A_{,}^3}$

$$\frac{B^3}{B_{,}^3} = \frac{B^3}{B^3(1+E_{,}^2 \sin^2 \vartheta)^{\frac{3}{2}}} = (1+E_{,}^2 \sin^2 \vartheta)^{-\frac{3}{2}}$$

$$(1+E_{,}^2 \sin^2 \vartheta)^{-\frac{3}{2}} = 1 - \frac{3}{2} E_{,}^2 \sin^2 \vartheta + \frac{3.5}{2.4} E_{,}^4 \sin^4 - \frac{3.5.7}{2.4.6} E_{,}^6 \sin^6 \vartheta + \text{etc.}$$

$$\frac{A^3}{A_{,}^3} = (1-E^2 \sin^2 \vartheta)^{-\frac{3}{2}} = 1 + \frac{3}{2} E^2 \sin^2 \vartheta + \frac{3.5}{2.4} E^4 \sin^4 \vartheta + \frac{3.5.7}{2.4.6} E^6 \sin^6 \vartheta + \text{etc.}$$

For oblate spheroid,

$$\text{Attraction of mass } (m \cos \vartheta) \&c = \frac{M}{D^2}\left(1 - \frac{3}{2} E_{,}^2 \sin^2 \vartheta + \frac{3.5}{2.4} E_{,}^4 \sin^4 \vartheta - \text{etc.}\right.$$

For prolate ellipsoid,

$$\text{Attraction of mass } (m' \cos \vartheta) \&c. = \frac{M'}{D_{,}^2}\left(1 + \frac{3}{2} E^2 \sin^2 \vartheta + \frac{3.5}{2.4} E^4 \sin^4 \vartheta + \text{etc.}\right.$$

12. In the above expressions for attraction any power of E or $E_{,}$ is a constant for any part or the whole of the same ellipsoid, while any power of $\sin \vartheta$ varies from 0 to 1. In case of the oblate ellipsoid having a constant semi minor axis (B) mass (m) varies as A^2, or as the mass of the whole ellipsoid till the ellipsoid becomes a sphere. The same relation is true of the

prolate spheroid. The coefficients, then, for eccentricity square, fourth power, etc., for the ellipsoid can be correctly computed from a sphere.

If we should represent the mass of the sphere by unity, and compute the fractional masses cut from the sphere by rotating a system of chords comprising an infinite number, extending from A to C and perpendicular to radius A C, and multiply each of the fractions by its requisite $\sin^2\vartheta$, the sum of the products would be the value for $\sin^2\vartheta$ for the whole of an ellipsoid. The same method is likewise true for computing the average value for any power of $\sin\vartheta$. Let $\sin^2\psi_2$, $\sin^4\psi_4$, $\sin^6\psi_6$, etc., be the average values for $\sin^2\vartheta$, $\sin^4\vartheta$, $\sin^6\vartheta$, etc., for the whole of a homegeneous ellipsoid with the attracted particle at the surface.

By using certain expedients wonderfully abbreviating the just described system of computation, I get the exact numerical values for $\sin^2\psi_2$, $\sin^4\psi_4$, $\sin^6\psi_6$, &c., and also for $\cos\psi_1$, $\cos^2\psi_2$, $\cos^3\psi_3$, &c. Which are:

$$^*\mathrm{Sin}^2\psi_2 = \frac{2}{5}.$$

$$\mathrm{Sin}^4\psi_4 = \frac{2.\ 4}{5.\ 7}.$$

$$\mathrm{Sin}^6\psi_6 = \frac{2.\ 4.\ 6}{5.\ 7.\ 9}.$$

$$\mathrm{Sin}^8\psi_8 = \frac{2.\ 4.\ 6.\ 8}{5.\ 7.\ 9.\ 11}, \text{ \&c. for higher powers.}$$

$$\mathrm{Cos}\,\psi_1 = \frac{3}{4}.$$

$$\mathrm{Cos}^2\psi_2 = \frac{3}{5}.$$

$$\mathrm{Cos}^3\psi_3 = \frac{3}{6}.$$

$$\mathrm{Cos}^4\psi_4 = \frac{3}{7} \text{ \&c. for higher powers.}$$

The expression for the attraction of the whole mass (M) of an oblate ellipsoid on a particle at the pole reduces to:

$$\frac{M}{B^2}\left(1 - \frac{3}{5}E_{,}^2 + \frac{3}{7}E_{,}^4 - \frac{3}{9}E_{,}^6 + \text{etc}\right).$$

The expression, &c., for the prolate ellipsoid becomes:

$$\frac{M'}{A^2}\left(1 + \frac{3}{5}{}^2E + \frac{3}{7}E^4 + \frac{3}{9}E^6 + \text{etc}\right).$$

13. Let $\frac{B}{D}$ or $\frac{A}{D}$ be represented by n. Since in a right angled triangle having a constant perpendicular while its hypothneuse and base increase in length, the sine of the angle at the base diminishes as the hypothenuse increases, and as each and all the angles ϑ that make up the angle ψ_2 are

---

*How these results are obtained is fully explained in the investigations on the subject referred to at the beginning of this paper.

from right angled triangles that have a common hypothenuse and each continues to have the same length of perpendicular as hypothenuse increases, therefore $\sin^2 \psi_2$ representing the average of all the $\sin^2 \vartheta$ varies as n^2. It can be shown likewise for $\sin^4 \psi_4$, etc., which represent the averages of all $\sin^4 \vartheta$, etc., that they vary as n^4, n^6, etc.

The expression, then, for the attraction of an oblate ellipsoid on a particle outside the pole is:

$$\frac{M}{D^2}\left(1-\frac{3}{5}n^2 E_{,}^2+\frac{3}{7}n^4 E_{,}^4-\frac{3}{9}n^6 E_{,}^6+\text{etc.}\right)$$

The expression, etc., for prolate ellipsoid is:

$$\frac{M}{D_{,}^2}\left(1+\frac{3}{5}n^2E^2+\frac{3}{7}n^4E^4+\frac{3}{9}n^6 E^6+\text{etc.}\right)$$

IV.

OUTSIDE ELLIPSOIDAL ATTRACTION IN PLANE OF THE EQUATOR.

First.—An oblate ellipsoid and an outside particle in plane of the equator attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $\left(1+\frac{1}{2}\times\frac{3}{5}n^2E^2+\frac{3}{2.4}\times\frac{3}{7}n^4E^4+\frac{3.5}{2.4.6}\times\frac{3}{9}n^6E^6+\text{etc.}\right)$ *and inversely as square of distance from center of ellipsoid to particle.*

Second.—A prolate ellipsoid and an outside particle in the plane of the equator attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $\left(1-\frac{1}{2}\times\frac{3}{5}n^2E_{,}^2+\frac{3}{2.4}\times\frac{3}{7}n^4E_{,}^4-\frac{3.5}{2.4.6}\times\frac{3}{9}n^6E_{,}^6+\text{etc.}\right)$, *and inversely as square of distance.*

14. This article finds a method of dividing an ellipsoid into an infinite number of wedges equal each to each, where the edges of the wedges are in an equatorial diameter.

In Diagram 5 let AB AB be a section of ellipsoid passing through the center of the ellipsoid and at rightangles to an equatorial diameter. Draw lines C a, C a^1, C a^2, etc., so that angles A C a, A C a^1, A C a^2, etc., can be represented by the alpha elliptic angles $\vartheta-z$, ϑ_1-z_1, ϑ_2-z_2, etc.; also draw lines C b, C b_1, C b_2, etc., so that angles B C b, B C b_1, B C b_2, etc., can be represented by the beta elliptic angles $\vartheta+y$, ϑ_1+y_1, ϑ_2+y_2, etc. When the elliptic angle becomes 45° then the z angle equals the y angle.

In Diagram 3 angle A C c or C c g corresponds to angle A C a of Dia. 5, and angle A C l or C l g of Dia. 3, to angle B C b of Dia. 5. In triangles C c g and C l g (Dia. 3), $c\,g = A \cos \vartheta$, and $l\,g = \frac{B^2}{A} \cos \vartheta$.

$\tan C\,c\,g : \tan C\,l\,g :: \frac{B^2}{A} \cos \vartheta : A \cos \vartheta :: B^2 : A^2$, or $\tan A\,C\,a : \tan B\,C\,b :: B^2 : A^2$.

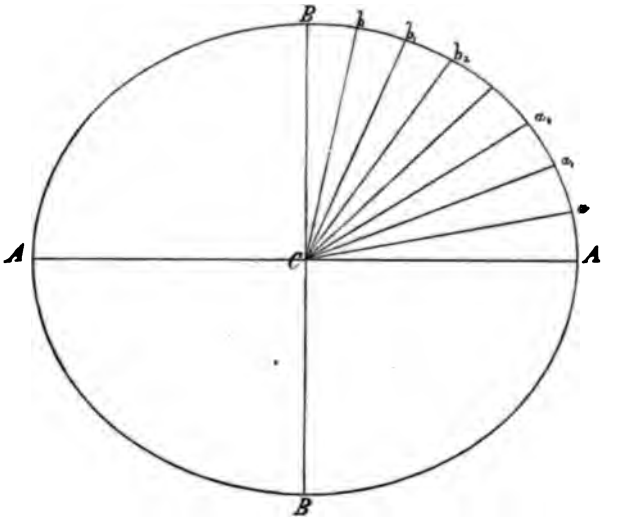


Diagram 5.

When the angles A C a and B C b become infinitesimal they are to each other as their tangents. Therefore infinitesimal angle A C a : angle B C b :: $B^2 : A^2$

The volume, then, of the wedge of the elipsoid measured by $A \times A^2 \times \frac{\text{ang. A Ca}}{360°}$ equals that measured by $A \times B^2 \times \frac{\text{ang. B Cb}}{360°}$ in case of the oblate ellipsoid. Likewise obtained, in the case of the prolate ellipsoid: $B \times A^2 \times \frac{\text{ang. A Ca}}{360°} = B \times B^2 \times \frac{\text{ang. B Cb}}{360°}$.

In Diagram 6 let A B A B be an ellipse having semi diameter C $B_,$ equal to $(B_,)$, and $B_,$ $b_,$ $B_,$ $b_,$ a similar ellipse having C $B_,$ equal to $(a_,)$, also let $B_,$ a $B_,$ be a circle with radius C $B_,$. From any point P in line C $B_,$ produced, draw tangent lines P $A_{,,}$, Pa, $Pb_{,,}$, and from points of tangency $A_{,,}$, a, and $b_{,,}$, draw $CA_{,,}$ Ca, and $Cb_{,,}$. Draw C $B_{,,}$ parallel to $A_{,,}$ P, and $Ca_{,,}$ parallel to $b_{,,}$ P. Then C $A_{,,}$ $(A_{,,})$ and C $B_{,,}$ $(B_{,,})$ are semi conjugate diameters in the one ellipse, and C $b_{,,}$ $(b_{,,})$ and $Ca_{,,}$ $(a_{,,})$ are corresponding semi conjugate diameters in the other.

Form points $A_{,}$, a, and $b_{,}$, draw ordinates to diameter $B_{,}$ $B_{,}$. These ordinates intersect diameter $B_{,}$ $B_{,}$ in a common point g, and C a g is an elliptic angle. $a\ g = B_{,} \cos \vartheta$, $A_{,}\ g = A_{,} \cos \vartheta$, and $b_{,}\ g = \frac{B_{,}^2}{A_{,}} \cos \vartheta$.

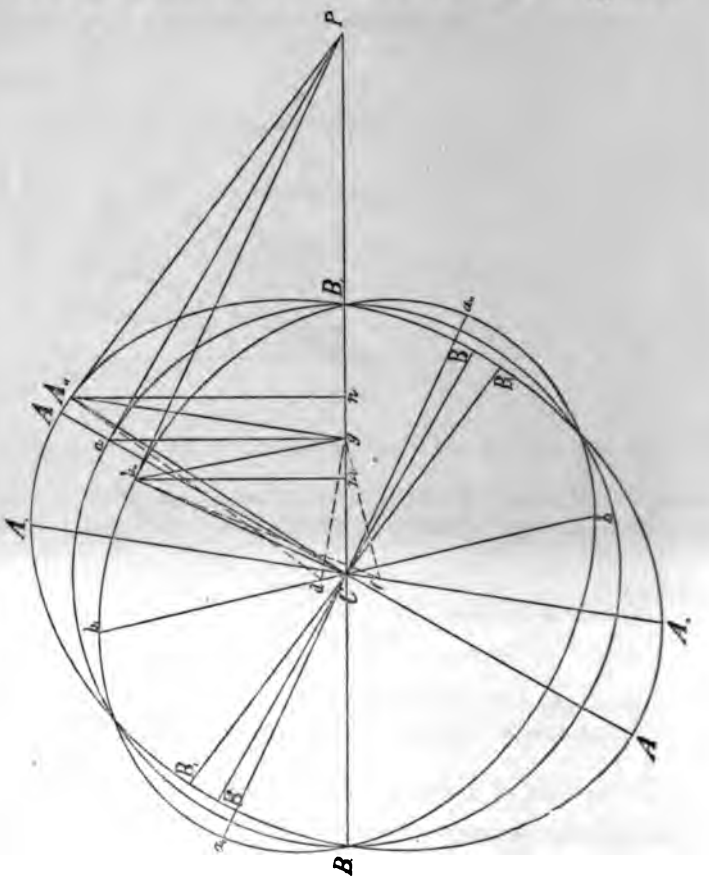


Diagram 6.

The ordinate $A_{,}$ g being parallel to to $A_{,}$ C ($A_{,}$), the angle C $A_{,}$ g is equal to the angle $A_{,}$ C $A_{,}$ or the angle that $A_{,}$ makes with $A_{,}$. Also $b_{,}$, g being parallel to $b_{,}$ C, the angle C $b_{,}$ g is equal to the angle that $b_{,}$ makes with $b_{,}$.

Draw $A_{,}$ n and $b_{,}$ m perpendicular to diameter $B_{,}$ $B_{,}$. Then 90° plus or minus the angle g $b_{,}$ m or g $A_{,}$ n (α) equals the angle that $A_{,}$ makes with $B_{,}$. Draw g d and g f each equal in length to g C, having angles d g C and f g C each equal to angle α. Then from the right angled triangles d $A_{,}$ g and f $b_{,}$ g having perpendicular d g equal to f $g_{,}$:

$$\tan d\ A_{,}\ g : \tan f\ b_{,}\ g :: \frac{B_{,}^2}{A_{,}} \cos \vartheta : A_{,} \cos \vartheta :: B_{,}^2 : A_{,}^2.$$

When angle ϑ becomes infinitesimal points d and f coincide with point C, and angle d $A_{,}$g equals C $A_{,}$g, and f $b_{,}$g equals C $b_{,}$g. Therefore infinitesimal angles C $A_{,}$g: C $b_{,}$g :: $B_{,}^2$: $A_{,}^2$

Form Art. 10,

$A_{,}^2 = A^2 - (A^2 - B^2) \sin^2 \vartheta.$

$B_{,}^2 = B^2 + (A^2 - B^2) \sin^2 \vartheta.$

Then $A_{,}^2 + B_{,}^2 = A^2 + B^2.$

Angle C $A_{,}$g represents any of the angles a C $a_{,}$, a, C a_2 etc., and C $b_{,}$g, any of the corresponding angles b C $b_{,}$, b, C b_2, etc., of Dia. 5. The volume of infinitesimal wedge then from an oblate ellipsoid measured by $A \times A_{,}^2 \times \frac{\text{Ang. a C a}_{,}}{360^\circ}$ equals that measured by $A \times B_{,}^2 \times \text{Ang.} \frac{\text{b C b}_{,}}{360^\circ}$

As $A_{,}^2 + B_{,}^2 = A^2 + B^2$, the iufinitesimal wedges of prolate ellipsoids, the sums of which make up the oblate ellipsoid are equal, each to each, in volume. The same can likewise be proved of wedges of a prolate ellipsoid.

15. To find, for any even power, an expression for the average of the eccentricities of all the infinitesimal wedges composing an ellipsoid, with edges in an equatorial diameter.

The edges of the elliptic wedges have a common semi-axis A and the other semi-axis varies from A to B as $A_{,}$ or $B_{,}$ vary from A to B.

$B_{,}$ for angle ϑ equals $A_{,}$ for angle $(90^\circ - \vartheta)$.

Eccentricity $\frac{A^2 - A_{,}^2}{A^2} = \frac{A^2 - B^2}{A^2} \sin^2\vartheta = E^2 \sin^2\vartheta = E^2 \cos^2(90^\circ - \vartheta).$

Eccentricity $\frac{A^2 - B_{,}^2}{A^2} = \frac{A^2 - B^2}{A^2} \cos^2\vartheta = E^2 \cos^2\vartheta = E^2 \sin^2(90^\circ - \vartheta).$

$$\frac{A^2 - A_{,}^2}{A^2} + \frac{A^2 - B_{,}^2}{A^2} + \frac{A^2 - A_2^2}{A^2} + \frac{A^2 - B_2^2}{A^2} + \frac{A^2 - A_3^2}{A^2} + \frac{A^2 - B_3^2}{A^2} + \text{\&c. to } 45^\circ,$$

Divided by the number of wedges equals,

$E^2(\sin^2\vartheta + \cos^2\vartheta + \sin^2\vartheta_{,} + \cos^2\vartheta_{,} + \sin^2\vartheta_2 + \cos^2\vartheta_2 + \text{\&c to } 45^\circ),$

divided by the number of wedges.

Trigonometry gives:

$\sin^2 \vartheta = \frac{1}{2} - \frac{1}{2} \cos 2\vartheta.$

$\cos^2 \vartheta = \frac{1}{2} + \frac{1}{2} \cos 2\vartheta.$

$$\frac{\sin^2 \vartheta + \cos^2 \vartheta}{2} = \frac{1}{2} = \sin^2 45^\circ = \cos^2 45.^\circ$$

The value $\frac{1}{2}$ is true for any pair of wedges. It is therefore the true value for the coefficient of E^2 in the expression $E^2 \sin^2 \vartheta$ which gives $\frac{1}{2} E^2$ for the average eccentricity squared of all wedges.

$\frac{(A^2 - A_{,}^2)^2}{A^4} + \frac{(A^2 - B_{,}^2)^2}{A^4}$ + etc., to ϑ for $45,^\circ$ divided by number of wedges, equals $E^4 (\sin^4 \vartheta + \cos^4 \vartheta)$ + etc., to ϑ for $45,^\circ$ divided by number of wedges.

$$\sin^4 \vartheta = \frac{1}{2^2} - \frac{1}{2} \cos 2\vartheta + \frac{1}{2^2} \cos^2 2\vartheta.$$

$$\cos^4 \vartheta = \frac{1}{2^2} + \frac{1}{2} \cos 2\vartheta + \frac{1}{2^2} \cos^2 2\vartheta.$$

$$\frac{\sin^4 \vartheta + \cos^4 \vartheta}{2} = \frac{1}{2^2} + \frac{1}{2^2} \cos^2 2\vartheta.$$

The first term $\left(\frac{1}{2^2}\right)$ of the above result is true for any value given to ϑ from 0° to 45°; therefore $\frac{1}{2^2}$ is the average for that term. It is now required to find the average of the succession of terms, $\frac{1}{2^2} \cos^2 2\vartheta + \frac{1}{2^2} \cos^2 2\vartheta_1 + \frac{1}{2^2} \cos 2\vartheta_2 +$ etc., to ϑ for 45°. When ϑ becomes 45°, 2ϑ becomes 90°; therefore these terms can be put in shape as follows: $\frac{1}{2^2}[\cos^2 2\vartheta + \cos^2(90° - 2\vartheta) + \cos^2 2\vartheta_1 + \cos^2(90° - 2\vartheta_1) + \cos^2 2\vartheta_2 + \cos^2(90° - 2\vartheta_2) +$ etc., to 2ϑ equal 45°], divided by the number of terms. The average value, then, for $\cos^2 2\vartheta$ is $\frac{1}{2}$. The average value of

$$\frac{1}{2^2} + \frac{1}{2^2} \cos^2 2\vartheta = \tfrac{1}{4} + \tfrac{1}{4} \times \tfrac{1}{2} = \tfrac{3}{8} = \frac{3}{2.4}$$

By like computation the average value of

$$\frac{\text{Sin}^6 \vartheta + \cos^6 \vartheta}{2} = \frac{1}{2^3} + \frac{3}{2^3} \cos^2 2\vartheta = \frac{15}{48} = \frac{3.5}{2.4.6}.$$

$$\frac{\text{Sin}^8 \vartheta + \cos^8 \vartheta}{2} = \frac{3.5.7}{2.4.6.8}.$$

$$\frac{\text{Sin}^{10} \vartheta + \cos^{10} \vartheta}{2} = \frac{3.5.7.9}{2.4.6.8.10},$$ etc., for higher powers.

For each of the infinitisimal wedges of an oblate ellipsoid, mass and distance squared are constant factors. The expression then for the attraction of an oblate ellipsoid on a particle outside in the plane of the equator is:

$$\frac{M}{D^2}\left(1 + \frac{1}{2} \times \frac{3}{5} n^2 E^2 + \frac{3}{2.4} \times \frac{3}{7} n^4 E^4 + \text{etc.}\right).$$

For a prolate ellipsoid, etc.:

$$\frac{M'}{D_{,}^2}\left(1 - \frac{1}{2} \times \frac{3}{5} n^2 E_{,}^2 + \frac{3}{2.4} \times \frac{3}{7} n^2 E_{,}^2 - \text{etc.}\right).$$

V.

COMPARISON OF ATTRACTION AT POLE AND EQUATOR, AND ATTRACTION OF CONFOCAL ELLIPSOIDS.

First. On an oblate ellipsoid the attraction at the pole exceeds that at the equator by $\frac{M}{A^2}\left(\frac{1}{10}E^2+\frac{19}{280}E^4+\frac{27}{560}E^6+\frac{163}{4480}E^8+\ldots\right)$ or by

$$\frac{M}{A^2}\left(\frac{1}{5}h+\frac{6}{35}h^2+\frac{4}{35}h^3+\frac{1}{14}h^4+\ldots\right)$$

Second. On a prolate ellipsoid the attraction at the equator exceeds that at the pole by $\frac{M}{A^2}\left(\frac{1}{10}E^2+\frac{37}{280}E^4+\frac{229}{1680}E^6+\ldots\right)$ or by $\frac{M}{A^2}\left(\frac{1}{5}h+\frac{3}{7}h^2+\ldots\right)$

Third. Confocal ellipsoids having foci at same points attract an outside particle in line of poles or plane of the equators directly as their masses.

In the above enunciations h equals $\frac{A-B}{A}$ or E^2 equals h (2—h).

16. The expression for the attraction at the pole of an oblate ellipsoid is

$$\frac{M}{B^2}\left(1-\frac{3}{5}E_{,}+\frac{3}{7}E_{,}^4-\frac{3}{9}E_{,}^6+\text{etc.}\right)$$ By substituting.

$\frac{E^2}{1-E^2}$ for $E_{,}^2$ and $A^2(1-E^2)$ for B^2, the expression becomes,

$$\text{(a)}\quad \frac{M}{A^2}\left(1+\frac{2}{5}E^2+\frac{2.4}{5.7}E^4+\frac{2.4.6}{5.7.9}E^6+\text{etc.}\right)$$

The expression for the same oblate ellipsoid at the equator is:

$$\text{(b)}\quad \frac{M}{A^2}\left(1+\frac{1}{2}\times\frac{3}{5}E^2+\frac{3}{2.4}\times\frac{3}{7}E^4+\frac{3.5}{2.4.6}\times\frac{3}{9}E^6+\text{etc.}\right)$$

Subtract expression (b) from (a) and the difference is:

$$\frac{M}{A^2}\left(\frac{1}{10}E^2+\frac{19}{280}E^4+\frac{27}{560}E^6+\frac{163}{4480}E^8+\ldots\right)$$

By substituting as above for E^2, and for B^2, the expression for the prolate ellipsoid at the equator becomes:

$$\text{(c)}\quad \frac{M}{A^2}\left(1+\frac{7}{10}E^2+\frac{157}{280}E^4+\frac{263}{560}E^6+\ldots\right)$$

The expression for Pole is:

$$\text{(d)}\quad \frac{M}{A^2}\left(1+\frac{3}{5}E^2+\frac{3}{7}E^4+\frac{3}{9}E^6+\text{etc.}\right)$$

$$\frac{M}{A^2}\left(\frac{1}{10}E^2+\frac{37}{280}E^4+\frac{229}{1680}E^6+\ldots\right)$$

equals difference.

17. To find the relation in law of attraction existing between two confocal ellipsoids having the same foci on a particle outside of both and in line of poles or plane of equator.

Let the semi major and the semi minor axes in the one be represented by a and b, and in the other by A and B.

$$e_{,}^2 = \frac{a^2 - b^2}{b^2}$$

$$E_{,}^2 = \frac{A^2 - B^2}{B^2}$$

$$e_{,}^2 : E_{,}^2 :: \frac{a^2 - b^2}{b^2} : \frac{A^2 - B^2}{B^2}$$

Since the ellipsoids are confocal.

$$a^2 - b^2 = A^2 - B^2.$$

(a) $e_{,}^2 : E_{,}^2 :: \frac{1}{b^2} : \frac{1}{B^2}$

(b) $e_{,}^4 : E_{,}^4 :: \frac{1}{b^4} : \frac{1}{B^4}$, etc. for higher powers.

It is evident from construction of right angled triangle Pa C in Dia. 4 that any sin ϑ for ellipsoid having ecentricity $e_{,}^2$ is to corresponding sin ϑ for ellipsoid having eccentricity $E_{,}^2$ as b to B. therefore

(c) $\sin^2 \vartheta : \sin^2 \vartheta_{,} :: b^2 : B^2$

(d) $\sin^4 \vartheta :: \sin^4 \vartheta'_{,} : b^4 : B_{,}^4$ etc. for higher powers.

Product of (a) and (c) is,

$$e_{,}^2 \sin^2 \vartheta : E_{,}^2 \sin^2 \vartheta_{,} :: \frac{b^2}{b^2} : \frac{B^2}{B^2} :: 1 : 1.$$

Product of (b) and (d) is,

$$e_{,}^4 \sin^4 \vartheta : E_{,}^4 \sin^4 \vartheta_{,} :: \frac{b^4}{b^4} : \frac{B^4}{B^4} : 1 : 1.$$

etc. for higher powers.

$$e_{,}^2 \sin^2 \vartheta + e_{,}^4 \sin^4 \vartheta + \text{etc} : E_{,}^2 \sin^2 \vartheta_{,} + E_{,}^4 \sin^4 \vartheta'_{,} + \text{etc.} :: 1 : 1.$$

This proves that confocal oblate ellipsoids attract an outside particle in line of poles directly as their masses.

Likewise it can be proven that confocal prolate ellipsoids in line of axis of rotation attract in conformity with law of masses.

As an ellipsoid can be made up of infinitesimal ellipsoidal wedges with edges in an equatorial diameter, confocal ellipsoids attract an outside particle in plane of equators as their masses.

It is evident that this law holds true for confocal ellipsoids made up of laminae varying in density from lamina to lamina providing corresponding laminae of each ellipsoid are of same density.

VI.

OUTSIDE ELIPSOIDAL ATTRACTION IN ANY DIRECTION.

First. — *An oblate ellipsoid and any outside partiele attract each other directly as product of mass of particle into mass of ellipsoid multiplied by* $[1-\frac{2}{3} n^2 E^2 (1-\frac{3}{2} \sin^2 O)-\frac{3}{5}E^4 (n^2-\frac{5}{7} n^4+\frac{3}{2} \sin^2 O -\frac{3}{8} \sin^4 O-4n^2 \sin^2 O +3n^2 \sin^4 O+\frac{127}{70} n^4 \sin^2 O-\frac{33}{40} n^4 \sin^4 O) +_{,}]$ *and inversely as square of distance from center of ellipsoid.*

Second — *The sine of the angle made by the direction of the resultant attraction, and the direction from the particle to the center of the ellipsoid equals* $\frac{3}{2} n^2 E^2 \sin O \cos O [1+E^2 (\frac{3}{2}-2 \sin^2 O-\frac{4}{7} n^2+\frac{33}{20} n^2 \sin^2 O) +_{,}]$.

Third — *The increase in attraction on an oblate ellipsoid from the equator to the poles true to the fourth power of eccentricilty varies as the square of the sine of the elliptic angle.*

In the above enunciations, n equals $B_{,}$ divided by D (distance), and O represents the elliptic angle used to find $B_{,}$.

18. To find an expression for the attraction on any outside particle, of any two opposite infinitesimal wedges of an ellipsoid with the edges in the diameter extending in direction to the particle.

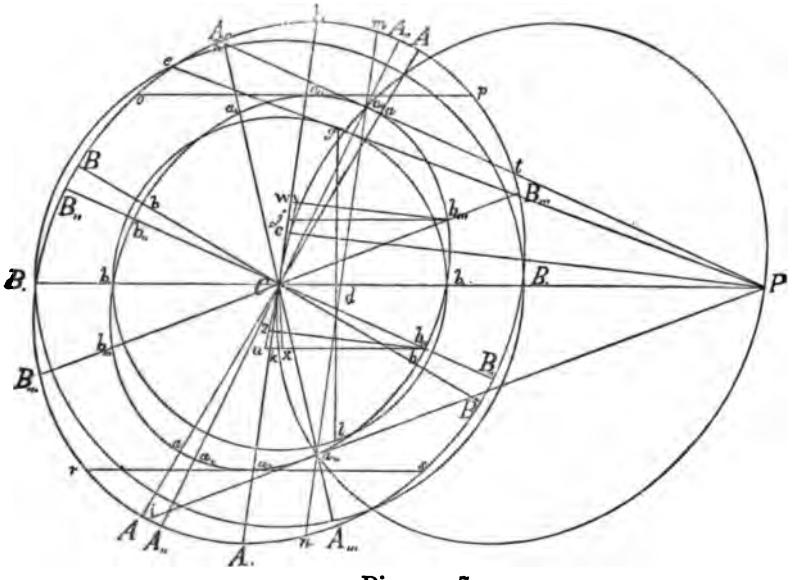


Diagram 7.

In diagram 7 let $B_{,}$ $B_{,}$ be the diameter of the ellipsoid extending in direction to the outside particle (P), A A and B B being the principal axes of the ellipsoid. This elliptic section rotated on axis $B_{,}$ $B_{,}$ through an in-

finitesimal angle represents the two opposite wedges in the plane of the principal axes. With C as a center and a a and b b as principal axes describe an ellipse similar to one having axes A A and B B, also describe circles with radii C $b_{,}$ and C $B_{,}$. On C P as a diameter corresponding to $B_{,}$ $B_{,}$ as a diameter describe another similar ellipse. From P draw Ph and Pi tangent lines to the ellipse having axes a a and b b. Draw diameter $B_{,,}$ $B_{,,}$ or $b_{,,}$ $b_{,,}$ parallel to tangent Ph, also diameter $B_{,,,}$ $B_{,,,}$ or $b_{,,,}$ $b_{,,,}$ parallel to tangent Pi. Through the points of tangency $a_{,,}$ and the center C draw the diameter $A_{,,}$ $A_{,,}$ or $a_{,,}$ $a_{,,}$, then $A_{,,}$ $A_{,,}$ and $B_{,,}$ $B_{,,}$ or $a_{,,}$ $a_{,,}$ and $b_{,,}$ $b_{,,}$ are conjugate diameters. $A_{,,,}$ $A_{,,,}$ and $B_{,,,}$ $B_{,,,}$ or $a_{,,,}$ $a_{,,,}$ and $b_{,,,}$ $b_{,,,}$ are likewise conjugate diameters. Through the points of tangency $a_{,,}$ and $a_{,,,}$ draw line m n, and diameter $A_{,}$ $A_{,}$ parallel to m n, then $A_{,}$ $A_{,}$ and $B_{,}$ $B_{,}$ or $a_{,}$ $a_{,}$ and $b_{,}$ $b_{,}$ are conjugate diameters, and $a_{,,}$ d and $a_{,,,}$ d are equal ordinates. From P draw line Pe tangent to the circle having radius C $b_{,}$, and from point of tangency g draw line g d l; then line g l is perpendicular to diameter $B_{,}$ $B_{,}$ and a double ordinate.*

From known demonstrations of *Conic Sections*,

g d : $a_{,,}$d :: $b_{,}$: $a_{,}$ :: $B_{,}$: $A_{,}$.

Draw radius g C and let angle C g d or its equal g P C be represented by ϑ. Then because g d = $b_{,}$ cos ϑ, and $a_{,,}$d = $a_{,}$ cos ϑ,

Thickness of elliptic wedge at $a_{,}$ is to that at $a_{,,}$ as $a_{,}$: $a_{,}$ cos ϑ or 1 : cos ϑ.

Likewise thickness of wedge at $a_{,}$ is to that at $a_{,,,}$ as 1 : cos ϑ.

Through $a_{,}$ and $a_{,}$ draw double ordinates o p and r s. These double ordinate are equal because they are equally distant from center C.

Per *Conic Sections*,

Chord o p : chord h t :: $B_{,}$: $B_{,,}$.

Chord r s : chord i f :: $B_{,}$: $B_{,,,}$.

Let α be the difference between a right angle and the angle C $a_{,}$ p or C $a_{,}$ s, also let b be the difference between a right angle and the angle C $a_{,,}$ t and $b_{,}$ that of a right angle and angle C $a_{,,,}$ f.

The differential width at $a_{,}$ corresponding to n l in Dia. 4 is to differential width at $a_{,,}$ corresponding to s a Dia. 4 as $A_{,}$ cos α : $A_{,,}$ cos b.

Also the differential width at $a_{,}$ is to that at $a_{,,,}$ as $A_{,}$ cos α : $A_{,,,}$ cos $b_{,}$

The product then of thickness at $a_{,}$ into length op into width at $a_{,}$ is to that of thickness at $a_{,,}$ into length h t into width at $a_{,,}$

$$\text{As} \left\{ \begin{array}{ccc} 1 & : & \cos\vartheta \\ B_{,} & : & B_{,,} \\ A_{,}\cos\alpha & : & A_{,,}\cos b \end{array} \right\} :: A_{,}B_{,}\cos\alpha : A_{,,}B_{,,}\cos\vartheta\cos b :: 1 : \cos\vartheta.$$

Because $A_{,}B_{,}$ cos a equals $A_{,,}B_{,,}$ cos b the last ratio above is true.

***These double ordinates and line P C should intersect at d.**

Likewise the product of the thickness at $a_{,}$ into length r s into width at $a_{,}$ is to that of the thickness at $a_{,,,}$ into length i f into width at $a_{,,,}$.

$$\text{As}\left\{\begin{array}{ccc} B_{,} & : & B_{,,,} \\ 1 & : & \cos\vartheta \\ A_{,}\cos\alpha & : & A_{,,,}\cos b_{,} \end{array}\right\} :: A_{,}B_{,}\cos\alpha : A_{,,,}B_{,,,}\cos b_{,}\cos\vartheta :: 1 : \cos\vartheta.$$

Mass-factor then at $a_{,}$ is to mass-factor at $a_{,,}$ or $a_{,,,}$ as $1 : \cos\vartheta$.

If in Diagram 7 conjugate diameters $A_{,}$ $A_{,}$ and $B_{,}$ $B_{,}$ were at right angles the chord element of mass and the wedge mass would be $\cos^2\alpha$, to unity greater. Regardless of the law of variations of the angle α, from wedge to wedge if we assume a homogenous solid made up of elliptic wedges having a common edge length of $B_{,}$ $B_{,}$, and limited in width by an ellipse with principal semi-axis $A_{,}$ and $A_{,}$ having its plane in center C and at right angles to diameter $B_{,}$ $B_{,}$, then we have a volume that can be divided into infinitesimal wedges of equal masses in accordance with Art. 14. If the ellipsoid be divided into wedges having the same angular thicknesses as those of the assumed solid, then the mass of any wedge of the ellipsoid is to the mass of the corresponding wedge of the assumed solid as the square of the cosine of the α angle ($\cos^2\alpha_{,}$) to unity. In the assumed solid let m represent the mass of the chord element, m that of the wedge and M, the mass of the whole solid; then in the ellipsoid $m\cos^2\alpha_{,}$ is the mass of the chord element, $m\cos^2\alpha_{,}$ that of the wedge. Let M be the mass of the ellipsoid.

Draw $k\ b_{,}$ and $j b_{,,}$ parallel to diameter $B_{,}$ $B_{,}$. As it was proven that $a_{,}d$ equals $a_{,}\cos\vartheta$ so, by similar construction of diagram with radius of circle $a_{,}$ C, with a point $P_{,}$ in extension of diameter $A_{,}$ A' and with points of tangency corresponding to $a_{,}$ and $a_{,,,}$ at $b_{,}$ and $b_{,,}$, it can be proven that $k\ b_{,}$ and $j\ b_{,,}$, each equals $b_{,}\cos\vartheta$.

By construction angle $Cb_{,}k$ equals angle $a_{,}PC$, and $Cb_{,,}j$ equals $a_{,,}PC$. Angle $b_{,}kC$ and $b_{,,}jC$ each varies from a right angle by the angle α. Let angle $a_{,}PC$ be represented by $\vartheta+u$, and $a_{,,}PC$ by $\vartheta-v$,

$$a_{,}P = \frac{D\sin a_{,}CP.}{\cos b}$$

From $a_{,}$ conceive a perpendicular drawn to diameter $B_{,}$ $B_{,}$. In construction then we have a right angled triangle with hypothenuse $Ca_{,}$ or $a_{,}$ and with perpendicular equal to $a_{,}\cos\vartheta\cos\alpha$, in which

$$\sin a_{,}CP = \frac{a'\cos\vartheta\cos\alpha}{a_{,}} = \frac{A_{,}\cos\vartheta\cos\alpha}{A_{,}}$$

$$a_{,}P = \frac{D\,A'\cos\vartheta\cos\alpha}{A_{,}\cos b}.$$

Likewise,

$$A_{,,,}P = \frac{D\,A_{,}\cos\vartheta\cos\alpha}{A_{,,}\cos b_{,}}$$

Draw line P c making an angle $(\alpha\pm z)$ with P C, and let P c be the resultant direction of attraction for the two opposite chord elements. Draw line v C u making angle u C k or v C w equal to angle z; and draw lines

$b_{,,,}$ v and $b_{,,}$ z parallel to Pc. Then right angled triangle $b_{,,,}$ v C has angle C $b_{,,,}$ v equal to $\vartheta - v + (\alpha \pm z)$; and right angled triangle $b_{,,}$ z C has angle C $b_{,,}$ z equal to $\vartheta + u - (\alpha \pm z)$. Produce line $b_{,,}$ k to u. $b_{,,}$ z u is a right angled triangle. In triangle u C k angle C k u equals $90° + \alpha$, angle k C u equals z and C u k equals $90° - (\alpha \pm z)$.

$$\text{Side u k} = \frac{A_{,} \sin \vartheta \sin z}{\cos (\alpha \pm z)}$$

$$b_{,,} u = B_{,} \cos \vartheta + \frac{A_{,} \sin \vartheta \sin z}{\cos (\alpha \pm z)}$$

$$b_{,,} z = B_{,} \cos \vartheta \cos (\alpha \pm z) + A_{,} \sin \vartheta \sin z.$$

Likewise,

$$b_{,,} v = B_{,} \cos \vartheta \cos (\alpha \pm z) - A_{,} \sin \vartheta \sin z.$$

In triangle $b_{,}$ z C,

$$\cos [\vartheta + u - (\alpha \pm z)] = \frac{B_{,} \cos \vartheta \cos (\alpha \pm z) + A_{,} \sin \vartheta \sin z}{B_{,}}$$

In triangle $b_{,,}$ v C,

$$\cos [\vartheta - v + (\alpha \pm z)] = \frac{B_{,} \cos \vartheta \cos (\alpha \pm z) - A_{,} \sin \vartheta \sin z}{B_{,,}}.$$

$$\text{Let } E^2 = \frac{A_{,}^2 - B_{,}^2}{B_{,}^2}$$

$$A_{,} = B_{,} \sqrt{1 + E^2}$$

$$\cos [\vartheta + u - (\alpha + z)] = \frac{B_{,} \cos \vartheta [\cos (\alpha \pm z) + \sqrt{1 + E^2} \tan \vartheta \sin z}{B_{,}}$$

Let $l = \cos (\alpha \pm z)$, and $n = \sqrt{1 + E^2} \tan \vartheta \sin z$.

For mass ($m \cos \vartheta \cos^2 \alpha$) at $a_{,}$ in direction Pc on particle P.

$$\text{Attraction} = \frac{m \cos^2 \alpha\, A_{,}^2\, B_{,} \cos^2 b \cos^2 \vartheta\, (l + n)}{D^2\, A_{,}^2\, B_{,} \cos^2 \vartheta \cos^2 \alpha} = \frac{m\, A_{,}^2\, B_{,} \cos^2 b\, (l + n)}{D^2 A_{,}^2 B_{,}}$$

$$A_{,}^2 = \frac{A_{,}^2\, B_{,}^2 \cos^2 \alpha}{B_{,}^2 \cos^2 b}.$$

$$\text{Att., etc., then} = \frac{m\, B_{,}^3\, (l + n) \cos^2 \alpha}{D^2\, B_{,}^3}.$$

Likewise for mass ($m \cos \vartheta \cos^2 \alpha$) at $a_{,,,}$ in direction Pc on particle P

$$\text{Att.} = \frac{m\, B_{,}^3\, (l - n) \cos^2 \alpha}{D^2\, B^3_{,,,}}$$

Draw C X perpendicular to $b_{,,}$ u, and draw a line from C perpendicular to $b_{,,,}$ j produced. In right angled triangle $b_{,,}$ X C, or in a right angled triangle similar having hypothenuse $B_{,,}$ C instead of $b_{,,}$ C,

Side for C X $= A_{,} \sin \vartheta \cos \alpha$.

Side for $b_{,,}$ X $= B_{,} \cos \vartheta - A_{,} \sin \vartheta \sin \alpha$.

Hyp. $B_{,,}^2 = B_{,}^2 \cos^2 \vartheta + A_{,}^2 \sin^2 \vartheta \sin^2 \alpha + A_{,}^2 \sin^2 \vartheta \cos^2 \alpha - 2 A_{,} B_{,} \sin \vartheta \cos \vartheta \sin \alpha.$

$$= B_{,}^2 \left[1 + E^2 \sin^2 \vartheta - 2 \sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha \right]$$

Likewise,

$$B_{,,,}^2 = B_{,}^2 [1 + E_{,}^2 \sin^2 \vartheta + 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha].$$

Let $s = E^2 \sin^2 \vartheta$, and $t = 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha$. By substitution and reduction.

$$\text{Att. etc., at } a_{,,} = \frac{m\,(1+n) \cos^2 \alpha}{D^2 [1 + (s-t)]^{\frac{3}{2}}}$$

$$\text{Att. etc., at } a_{,,,} = \frac{m\,(1-n) \cos^2 \alpha}{D^2 [1 + (s+t)]^{\frac{3}{2}}}$$

$$\frac{1+n}{[1+(s-t)]^{\frac{3}{2}}} = (1+n)[1 - \tfrac{3}{2}(s-t) + \frac{3.5}{2.4}(s-t)^2 - \text{etc}].$$

$$= (1+n)(1 - \tfrac{3}{2} s + \tfrac{3}{2} t + ,,).$$

For mass at $a_{,,}$ in direction pc on p.

$$\text{Att.} = \frac{m\,(1+n) \cos^2 \alpha}{D^2} (1 - \tfrac{3}{2} s \pm \tfrac{3}{2} t + ,,).$$

For mass at $a_{,,,}$ etc.

$$\text{Att.} = \frac{m\,(1-n) \cos^2 \alpha}{D^2} (1 - \tfrac{3}{2} s - \tfrac{3}{2} t + ,,).$$

Multiply the first series by $(1+n)$ and the second by $(1-n)$ and divide the sum of the results by two and we get

$$\text{Average Att.} = \frac{m \cos^2 \alpha}{D^2} (1 - \frac{3}{2} ls + \frac{3}{2} nt + \frac{3.5}{2.4} ls^2 + \frac{3.5}{2.4} lt^2 - \frac{3.5}{4} nst - ,,).$$

$$l = \cos(\alpha \pm z) = 1 - \tfrac{1}{2} \sin^2 (\alpha \pm z) - \frac{1}{2.4} \sin^4 (\alpha \pm z) - \text{etc.}$$

Replacing the values of l, s, n and t,

$$(a.)\ \text{Att.} = \frac{m \cos^2 \alpha}{D^2} \Big[1 - \frac{3}{2} E^2 \sin^2 \vartheta + \frac{3.5}{2.4} E^4 \sin^4 \vartheta + \frac{3.5}{2} \sin^2 \vartheta \sin^2 \alpha - \frac{3.5}{2} \sin^4 \vartheta \sin^2 a \pm 3 \sin^2 \vartheta \sin \alpha \sin z - \frac{1}{2} \sin^4 (\alpha \pm z) - \frac{3.\,4.\,5.}{2.\,5.\,7.} E^6 \sin^6 \vartheta + , \Big].$$

Let $(a+y)$ be the angle that line PC makes with the resultant direction of attraction for the two opposite wedges, then any two corresponding opposite chord elements contribute in the attraction of the two opposite wedges.

$$(b.)\ \text{Att.} = \frac{m \cos^2 \alpha}{D^2} \Big[1 - \frac{3}{2} E^2 \sin^2 \vartheta + \frac{3.5}{2.4} E^4 \sin^4 \vartheta + \frac{3.5}{2} \sin^2 \vartheta \sin^2 \alpha - \frac{3.5}{2} \sin^4 \vartheta \sin^2 \alpha \pm 3 \sin^2 \vartheta \sin \alpha \sin y - \frac{1}{2} \sin^2 (a \pm y) - \frac{3.5.7}{2.4.6} E^6 \sin^6 \vartheta + , \Big]$$

In the above expression (b), for the two opposite wedges, angles α and $(\alpha \pm y)$ as well as eccentricity E are constant quantities. In accordance then with the expedient of Art. 12 for summation, an expression for the attraction of the two opposite infinitesimal wedges on particle P is found by putting

$$\text{Sin}^2\, \vartheta = \frac{2}{5} n^2.$$

$$\text{Sin}^4\, \vartheta = \frac{2.\,4}{5.\,7} n^4.$$

$$\text{Sin}^6\, \vartheta = \frac{2.\,4.\,6}{5.\,7.\,9} n^6. \quad \text{Etc., for higher power .}$$

For the two opposite wedges in the plane of the principal axes of the ellipsoid on particle P,

$$\text{Att.} = \frac{m \cos^2 \alpha}{D^2} \left[1 - \frac{3}{5} n^2 E^2 + \frac{3}{7} n^4 E^4 + 3 n^2 \sin^2 \alpha - \frac{12}{7} n^4 \sin^2 \alpha \pm \frac{6}{5} n^2 \right.$$

$$\left. \sin \alpha \sin y - \frac{1}{2} \sin^2 (\alpha \pm y) - \frac{3}{9} n^6 E^6 + . \right]$$

In any two opposite wedges let $E_{,}$ represent the excentricity and angle $(\alpha_{,} + y_{,})$, the direction of the resultant, then for any two opposite wedges:

$$\text{Att} = \frac{m \cos^2 \alpha_{,}}{D^2} \left[1 - \frac{3}{5} n^2 E_{,} + ' \right]$$

$$\text{(c)} \quad \text{Att} = \frac{m}{D^2} \left[1 - \frac{3}{5} n^2 E_{,}^2 + \frac{3}{7} n^4 E_{,}^4 - \sin^2 \alpha_{,} + 3 n^2 \sin^2 \alpha_{,} - \frac{12}{7} \right.$$

$$\left. n^4 \sin^2 a_{,} \pm \frac{6}{5} n^2 \sin a_{,} \sin y_{,} - \frac{1}{2} \sin^2 (\alpha \pm y) - \frac{3}{9} n^6 E_{,}^6 + . \right]$$

19. To find an expression for angle α, and for the eccentricity $E_{,}^2$ of any wedge.

Let O be the elliptic angle for the ellipse having A and B for semi major and semi minor axes, and let ξ be the elliptic angle for the ellipse having A and $A_{,}$ for semi major and semi minor axes; also let $a_{,}$ be any semi diameter of the ellipse having A and $A_{,}$ for semi major and semi minor axes, and let b be the semi minor axis of the ellipse having A for semi major axis and $a_{,}$ and $B_{,}$ for semi conjugate diameters.

For any infinitesimal wedge of the ellipsoid having its edge in diameter $B_{,} B_{,}$,

$$\text{Sin}^2\, \alpha_{,} = \frac{a_{,}^2 B_{,}^2 - A^2 b^2}{a_{,}^2 B_{,}^2}$$

$$B_{,}^2 = B^2 + (A^2 - B^2) \sin^2 O.$$

$$a_{,}^2 = A^2 - (A^2 - B^2) \sin^2 O \sin^2 \xi.$$

$$a_{,}^2 + B_{,}^2 = A^2 + B^2 + (A^2 - B^2) \sin^2 O \cos^2 \xi.$$

Per *Conic Sections,*

$A^2 + b^2 = a_{,}^2 + B_{,}^2$.

Therefore $b^2 = B^2 + (A^2 - B^2) \sin^2 O \cos^2 \xi$.

$a_{,}^2 B_{,}^2 - A^2 b^2 = (A^2 - B^2)^2 \sin^2 O \cos^2 O \sin^2 \xi$.

$$\text{Sin}^2 \alpha_{,} = \frac{(A^2-B^2)^2 \sin^2 O \cos^2 O \sin^2 \xi}{a_{,}^2 B_{,}^2} = \frac{E^4 \sin^2 O \cos^2 O \sin^2 \xi}{(1-E^2 \sin^2 O \sin^2 \xi)(1-E^2 \cos^2 O)}.$$

$\text{Sin}^2 \alpha_{,} = E^4 \sin^2 O \cos^2 O \sin^2 \xi + E^6 \sin^2 O \cos^4 O \sin^2 \xi + ,$

$\text{Sin}\, \alpha_{,} = E^2 \sin O \cos O \sin \xi + \frac{1}{2} E^4 \sin O \cos^3 O \sin \xi + \frac{1}{2} E^4 \sin^3 O \cos O \sin^2 \xi + \frac{1}{2} E^6 \sin^3 O \cos^3 O \sin^3 \xi - ,.$

$E_{,}^2 = \frac{a_{,}^2 - B_{,}^2}{B_{,}^2} = E^2 \cos^2 O - E^2 \sin^2 O \sin^2 \xi + E^4 \cos^4 O - E^4 \sin^2 O \cos^2 O \sin^2 \xi + E^6 \cos^6 O - ,$

$E_{,}^4 = E^4 \cos^4 O - 2 E^4 \sin^2 O \cos^2 O \sin^2 \xi + E^4 \sin^4 O \sin^4 \xi + 2 E^6 \cos^6 O - ,.$

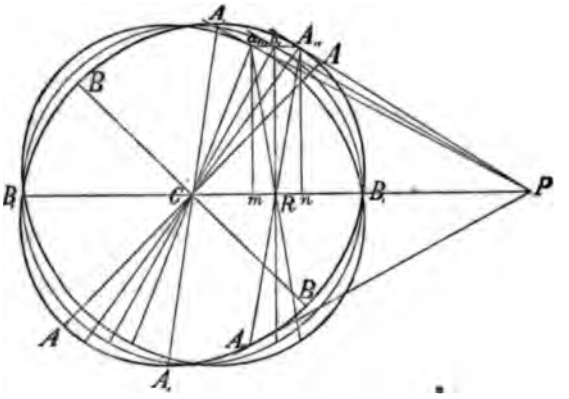


Diagram 8.

To find an expression for angle $(\alpha_{,} + y_{,})$ for any two opposite wedges.

Diagram 8 is constructed in accordance with diagram 7, having lower part laid over so that point $A_{,,,}$ becomes $a_{,,,}$. $A_{,,}$ n and $a_{,,,}$ m are drawn perpendicular to P C. Angle $a_{,,,}$ R $A_{,}$ equals 2α, C $b_{,}$ R or $b_{,}$ P C equals ϑ, $A_{,,}$ P R equals $(\vartheta + \varkappa)$ and $a_{,,}$ P R equals $(\vartheta - v)$.

In triangle $A_{,}$ $Pa_{,,}$,

(a). $\sin A_{,} Pa_{,,}$ or $\sin(\varkappa + v) = \frac{2 \sin \alpha}{\cos \alpha} \sin(\vartheta + \varkappa) \sin(\vartheta - v)$.

$Pb_{,} = D \cos \vartheta$; $PR = D \cos^2 \vartheta$; and $b_{,} R = D \sin \vartheta \cos \vartheta$.

$A_{,,} R = a_{,,,} R = \frac{A_{,}}{B_{,}} D \sin \vartheta \cos \vartheta = \sqrt{1+E^2}\, D \sin \vartheta \cos \vartheta$

$A_{,,} n = a_{,,,} m = \sqrt{1+E^2}\, D \sin \vartheta \cos \vartheta \cos \alpha,$

$$R\,n = R\,m = \sqrt{1+E^2}\,D \sin\vartheta \cos\vartheta \sin\alpha$$

$$P\,n = D\cos\vartheta\left(\cos\vartheta - \sqrt{1+E^2}\sin\vartheta\sin\alpha\right)$$

$$P\,m = D\cos\vartheta\left(\cos\vartheta + \sqrt{1+E^2}\sin\vartheta\sin\alpha\right)$$

$$A_{,}P = \sqrt{\overline{Pn}^2 + \overline{A_{,}n}^2} = D\cos\vartheta\left[1+E^2\sin^2\vartheta - 2\sqrt{1+E^2}\sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}$$

$$A_{,,}P = \sqrt{\overline{Pm}^2 + \overline{a_{,,}m}^2} = D\cos\vartheta\left[1+E^2\sin^2\vartheta + 2\sqrt{1+E^2}\sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}$$

$$\text{Sin}\,(\vartheta+u) = \frac{A_{,}n}{A_{,}P} = \frac{\sqrt{1+E^2}\sin\vartheta\cos\alpha}{\left[1+E^2\sin^2\vartheta - 2\,(1+E^2)^{\frac{1}{2}}\sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}}$$

$$\text{Sin}\,(\vartheta-v) = \frac{a_{,,}m}{a_{,,}P} = \frac{\sqrt{1+E^2}\sin\vartheta\cos}{\left[1+E^2\sin^2\vartheta + 2\,(1+E^2)^{\frac{1}{2}}\sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}}$$

$$\text{Sin}\,(\vartheta+u)\sin(\vartheta-v) = \frac{\left(1+E^2\right)\sin^2\vartheta\cos^2\alpha}{\left[(1+E^2\sin^2\vartheta)^2 - 4\,(1+E^2)\sin^2\vartheta\cos^2\vartheta\sin^2\alpha\right]^{\frac{1}{2}}}$$

Expand and reduce this value for sin $(\vartheta+u)$ sin $(\vartheta-v)$, and substitute the result in expression (a) of this Art.,

$$\text{Sin}(u+v) = 2\sin\alpha\cos\alpha\,(\sin^2\vartheta + E^2\sin^2\vartheta - E^2\sin^4\vartheta - E^4\sin^4\vartheta + E^4\sin^6\vartheta$$
$$+2\sin^4\vartheta\sin^2\alpha - 2\sin^6\vartheta\sin^2\alpha + E^6\sin^6\vartheta - {}_{,}).$$

$$\text{Sin}\,(u+v) = 2\sin\alpha\,(\sin^2\vartheta + E^2\sin^2\vartheta - E^2\sin^4\vartheta - E^4\sin^4\vartheta + E^4\sin^6\vartheta - \tfrac{1}{2}$$
$$\sin^2\vartheta\sin^2\alpha + 2\sin^4\vartheta\sin^2\alpha - 2\sin^6\vartheta\sin^2\alpha + E^6\sin^6\vartheta - {}_{,})$$

$$\tan(u+v) = 2\sin\alpha\,(\sin^2\vartheta + E^2\sin^2\vartheta - E^2\sin^4\vartheta - E^4\sin^4\vartheta + E^4\sin^6\vartheta - \tfrac{1}{2}\sin^2\vartheta\sin^2\alpha + 2\sin^4\vartheta\sin^2\alpha + E^6\sin^6\vartheta - {}'').$$

The difference $(4\sin^6\vartheta\sin^3\alpha)$ between tan u+v) and sin (u+v) is of the order of the sixth power of eccentricity, therefore to the sixth power of eccentricity, per this method of development, the sine, the arc and the tangent of the angle (u+v) are of the same length.

Diagram 9 is so constructed that triangles $A_{,,}$ P R and $A_{,,,}$ P R are equal to triangles like lettered in Dia. 8. In line P $A_{,,,}$ take P B equal to P $A_{,,}$, and let it be represented by unity. Produce P $A_{,,}$ to D, making P D equal to P $A_{,,,}$, and let it be represented by (1+a). Produce P D to F making P F equal to $(1+a)^2$. Complete parallograms P $A_{,,}$ C B, P D E B and P F G B, and draw diagonals P C, P E and P G.

By construction angles R P C and E P C are equal, and either of these angles is equal to half the difference of the angles P E D and E P D or E P B. Angle C P G is also half the difference of angles P G F and G P F or G P B. Diagonal P G is the direction of the resultant of the two forces represented by the lines 1 and $(1+a)^2$.

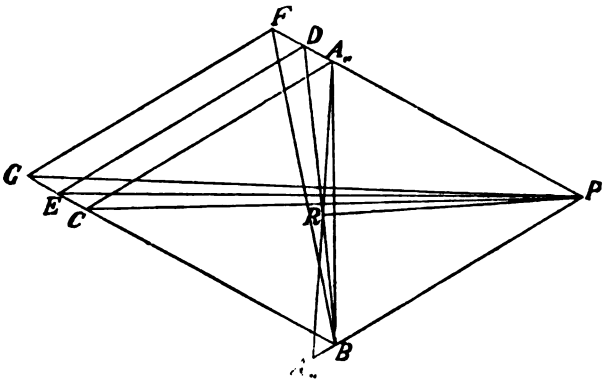


Diagram 9.

Angle R P E is equal to angle (u+v).

In triangle P E D,

$$\tan \frac{PED + EPD}{2} = \tan CPE \frac{2+a}{a}.$$

In triangle P G F,

$$\tan \frac{PGF + GPF}{2} = \tan CPG \frac{2+2a+a^2}{2a+a^2}$$

The half sum of angles PED and EPD is equal to the half sum of angles PGF and GPF, therefore

$$\tan CPE \frac{2+a}{a} = \tan CPG \frac{2+2a+a^2}{2a+a^2}$$

$$\frac{\tan CPG}{\tan CPE} = 2 - \tfrac{1}{2} a^2 + \tfrac{1}{2} a^3 - \tfrac{1}{4} a^4 + ,$$

From values of $A_{,,}P$ and $a_{,,}P$ already developed in this Art.,

$$a = 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha - 2E^2\sqrt{1+E^2} \sin^3 \vartheta \cos \vartheta \sin \alpha + (1+E^2)^{\frac{3}{2}} \sin^2 \vartheta \cos^2 \sin^3 \vartheta \alpha + ,$$

$$a^2 = 4 \sin^2 \vartheta \cos^2 \vartheta \sin^2 \alpha + ,$$

The angle CPE is one half of angle RPE or $\frac{1}{2}$ (u+v).

$$\tan \frac{u+v}{2} = \frac{1-\cos(u+v)}{\sin(u+v)} = \frac{1}{2} \sin(u+v) + \frac{1}{2.4} \sin^3(u+v) + \text{etc.}$$

$$\tan CPG = 2(1 - \sin^2 \vartheta \cos^2 \vartheta \sin^2 \alpha + ,) \tan \frac{u+v}{2}$$

$$\tan(\alpha \pm z) = \tan\left(CPG + \frac{u+v}{2}\right) = \frac{\tan CPG + \tan\frac{u+v}{2}}{1 - \tan CPG \tan\frac{u+v}{2}}$$

$$\sin(\alpha \pm z) = \frac{\tan(\alpha \pm z)}{\sqrt{1+\tan^2(\alpha \pm z)}}$$

As the chord elements of attraction from wedge to wedge vary in mass as $m \cos^2 \alpha$ the above expression for $\sin(\alpha \pm z)$ must be multiplied by $m \cos^2 \alpha$. Thus modified and expanded,

$$\sin(\alpha \pm z) = 3m \cos^2 \alpha \sin \alpha (\sin^2 \vartheta + E^2 \sin^2 \vartheta - \ldots).$$

$$\sin(\alpha \pm z) = 3m \sin \alpha (\sin^2 \vartheta + E^2 \sin^2 \vartheta - E^2 \sin^4 \vartheta - E^4 \sin^4 \vartheta + E^4 \sin^4 \vartheta - \frac{3}{2} \sin^2 \vartheta \sin^2 \alpha + \frac{4}{3} \sin^4 \vartheta \sin^2 \alpha - \frac{23}{6} \sin^6 \vartheta \sin^2 \alpha + E^6 \sin^6 \vartheta - \ldots)$$

The letters in the above expression are for the plane of the principal axes. For any plane substitute $\alpha_{,}$, $E_{,}$, m, and $y_{,}$ for z. As $\alpha_{,}$ and $E_{,}$ are constant quantities for any two opposite wedges, summation of chord elements for opposite wedges can be made per expedient of Art. 12, by putting:

$$\sin^2 \vartheta = \frac{2}{5} n^2.$$

$$\sin^4 \vartheta = \frac{2.4}{5.7} n^4, \text{ etc., for higher powers.}$$

$$\sin(\alpha_{,} \pm y_{,}) = \frac{6}{5} m \sin \alpha_{,} n^2 \left(1 + E_{,}^2 - \frac{4}{7} E_{,}^2 n^2 - \frac{4}{7} E_{,}^4 n^2 + \frac{4.6}{7.9} E_{,}^4 n^4 - \frac{3}{2} \sin^2 \alpha_{,} + \frac{16}{21} n^2 \sin^2 \alpha_{,} - \frac{92}{63} n^4 \sin^2 \alpha_{,} + \frac{4.6}{7.9} E_{,}^4 - \ldots\right)$$

Substitute in the above expression the values given for $\sin \alpha_{,}$ and eccentricity ($E_{,,}$) in Art. 19.

$$\text{(b.)} \quad \sin(\alpha_{,} \pm y_{,}) = \frac{6}{5} \frac{m n^2 E^2 \sin O \cos O \sin \xi}{[(1 - E^2 \sin^2 O \sin^2 \xi)(1 - E^2 \cos^2 O)]^{\frac{1}{2}}}$$

$$[1 + E^2 \cos^2 O (1 - \tfrac{4}{7} n^2) - E^2 \sin^2 O \sin^2 \xi (1 - \tfrac{4}{7} n^2) + E^4 \cos^4 O (1 - \tfrac{8}{7} n^2 + \tfrac{8}{21} n^4) - E^4 \sin^2 O \cos^2 O \sin^2 \xi (\tfrac{5}{7} - \tfrac{88}{21} n^2 + \tfrac{20}{9} n^4) - \tfrac{4}{7} n^4 E^4 \sin^4 O \sin^4 \xi (1 - \tfrac{3}{2} n^2) + \ldots].$$

21. To find the resultant direction of attraction for the whole Ellipsoid. For any two opposite wedges there are two corresponding opposite wedges in the adjacent quarters of the Ellipsoid. The resultant for these four wedges is found by multiplying the expression for the resultant of either of the two opposite wedges by the cosine of the angle [90° minus the alpha elliptic angle ($\xi - b$)], or the sine of the alpha elliptic angle ($\xi - b$). Let ($\alpha_{,} \pm y_{,}$ be the angle for the resultant of the four wedges.

$$\sin(\xi - b) = \frac{A_{,} \sin \xi}{a_{,}} = \frac{\sin \xi (1 - E^2 \sin^2 O)^{\frac{1}{2}}}{(1 - E^2 \sin^2 O \sin^2 \xi)^{\frac{1}{2}}}.$$

Multiply this value for $\sin(\xi - b)$ by expression (b) Art. 20, then the expression for the resultant of the four wedges is,

$\sin(a, \pm y_{,}) = \frac{8}{5} m n^2 E^2 \sin O \cos O [(1 + \frac{3}{2} E^2 - 2 E^2 \sin^2 O - \frac{4}{7} n^2 E^2 + \frac{4}{7} n^2 E^2 \sin^2 O) \sin^2 \xi + \frac{4}{7} n^2 E^2 \sin^2 O \sin^4 \xi \pm_{,}]$.

If the attraction of the pairs of wedges were equal, each to each, then per Art. 15, the resultant of attraction for the whole ellipsoid would be found by putting,

$$\sin^2 \xi = \tfrac{1}{2}$$

$$\sin^4 \xi = \frac{3}{2.4}, \text{ etc. for higher powers.}$$

Let $(\alpha \pm w')$ be the approximate angle for the resultant so found.

(a) $\sin(\alpha \pm w') = \frac{8}{5} Mn^2 E^2 \sin \theta \cos \theta_{,}[1 + E^2(\frac{3}{2} - 2 \sin^2 O - \frac{4}{7} n^2 + n^2 \sin^2 O) + E^4(^{,}) +_{,}]$.

To correct this result let (s) be the angle that the resultant of any four wedges having the angle ξ greater than 45°, makes with the resultant of the four wedges so taken that the square of the sine of angle ξ in first plus the square of the sine of angle ξ in the second shall equal unity. The correction for any such group of eight wedges is the difference of a certain two angles the sum of which is a certain angle (s). Let p and r be these angles. Expressions for the sum and difference of the resultant attractions for the two four wedge groups are obtainable from expression (c) Art. 18. By a well known trigonometrical method the expression for the tangent of the half difference of the two angles p and r is:

$$\tan \frac{p-r}{2} = \frac{9}{50} MN^4 E^4 \sin^3 O \cos O [(1 + E^2(_{,}) (2 \sin^2 \xi - 1)^2 \pm_{,}].$$

$$(2 \sin^2 \xi - 1)^2 = 1 - 4 \sin^2 \xi \cos^2 \xi.$$

The expression $[\sin^2 a \cos^2 a + \sin^2 (45° - a) \cos^2 (45° - a] = \frac{1}{4}$, from well-known trigonometrical fromulæ, proves that the value of $\sin^2 \xi \cos^2 \xi$ for any and every group of eight wedges or for the average of all groups composing the ellepsoid is $\frac{1}{8}$, therefore, for the whole ellipsoid the correction becomes:

$$\tan \frac{p-r}{2} = \frac{9}{100} Mn^4 E^4 \sin^3 O \cos O [(1 + E^2(_{,}) +_{,}].$$

$$\sin \frac{p-r}{2} = \frac{9}{100} Mn^4 E^4 \sin^3 O \cos O [1 + E^2(_{,}) +^{,}].$$

This correction united additionally, as the conditions require it, to expression (a) of this Art. gives:

$\sin(\alpha - w) = \frac{8}{5} Mn^2 E^2 \sin O \cos O [1 + E^2 (\frac{3}{2} - 2 \sin^2 O - \frac{4}{7} n^2 + \frac{8}{10} n^2 \sin^2 O) + E^4(_{,}) +_{,}]$.

This method of correction gives an expression exactly true to the eighth power of eccentricity. Another order of correction, similar to the one treated, commences with the eighth power of ecentricity, but its effect is small when eccentricity is large, owing to the fact that each group of eight wedges to be combined in the next order of resultants, is so composed of wedges from different parts of the ellipsoid, that the attractions of all groups of eight are very nearly equal each to each.

$$M = \frac{M^*}{1-\sin^2 a_{,}} = \frac{M}{1-\frac{1}{2}E^4 \sin^2 O \cos^2 O^2 + \cdots}$$

Substitute this value for M in the above expression for $\sin(\alpha - W)$ and we get for the whole ellipsoid the angle that the direction of attraction makes with the direction from the attracted particle to the center of the ellipsoid.

$$\text{(b)}\ \sin(\alpha - W) = \frac{3}{5} M n^2 E^2 \sin O \cos O \Big[1 + E^2 \Big(\frac{3}{2} - 2\sin^2 O - \frac{4}{7} n^2 + \frac{23}{20} n^2 \sin^2 O\Big) + E^4 (\ldots) + \cdots \Big]$$

When the attracted particle is at the surface of the ellipsoid n becomes uni y and the expression is:

$$\text{(c)}\ \sin(\alpha - W) = \frac{3}{5} M E^2 \sin O \cos O \Big[1 + E^2 \Big(\frac{13}{14} - \frac{17}{20}\sin^2 O\Big) + E^4 (\ldots) + \ldots \Big]$$

$$\sin(\alpha - W) = \frac{3}{5} M \sin O \cos O \Big[E^2 + E^4 \Big(\frac{13}{14} - \frac{17}{20}\sin^2 O\Big) + E^6 (\ldots) + \ldots \Big]$$

In the above, in order to get the term depending on E^4 exact. it is to be observed that M can be used for M, angle ξ, for $(\xi - b)$ and arc of angle α for sine or tangent, also so far as the expression is dependent on attraction (c) Art. 18 the terms E^4 and $\sin^2 \alpha$ are not involved.

22. To find the attraction of an oblate ellipsoid on any outside particle.

By requisite substitution, expression (c) Art. 18 for two opposite wedges becomes:

$$\text{(a)}\ \text{Att.} = \frac{m}{D^2}\Big(1 - \frac{3}{5}n^2E^2\cos^2 O + \frac{3}{5}n^2E^2\sin^2 O \sin^2\xi - \frac{3}{5}n^2E^4\cos^4 O + \frac{3}{7}n^4E^4\cos^4 O + \frac{3}{7}n^4E^4\sin^4 O \sin^4\xi - \frac{43}{25}E^4\sin^2 O\cos^2 O\sin^2\xi + \frac{12}{5}n^2E^4\sin^2 O\cos^2 O\sin^2\xi - \frac{198}{175}n^4E^4\sin^2 O\cos^2 O\sin^2\xi + \ldots\Big).$$

Expression (b) Art. 20 modified for tangent and reduced gives:

$$\tan(\alpha_{,} + y_{,}) = \frac{6}{5}n^2E^2\sin O\cos O\sin\xi\Big(1 + \frac{3}{2}E^2\cos^2 O - \frac{4}{7}n^2E^2\cos^2 O - \frac{1}{2}E^2\sin^2 O\sin^2\xi + \frac{4}{7}n^2E^2\sin^2 O\sin^2\xi + \ldots\Big).$$

---

* The Italic M represents greater mass than the Roman in this investigation.

Expression (b) Art. 21 gives:

$$\tan(\alpha - w) = \frac{3}{5} n^2E^2 \sin O \cos O \left(1 + \frac{3}{2} E^2 - 2 E^2 \sin^2 O - \frac{4}{7} n^2 E^2 + \frac{23}{20} n^2 E^2 \sin^2 O + \ldots\right).$$

$(\alpha_{,} \pm y_{,})$ is the angle that D* makes with the resultant of any two opposite wedges. and $(\alpha - w)$ is the angle that D also makes with the resultant for the whole ellipsoid. The tangents of the angles having the same radius (D) are in the same plane perpendicular to D. To determine the distance of the resultant of any two opposite wedges from the resultant of the whole ellipsoid, these tangents may represent the adjacent side of a triangle having the included angle $[90° - (\xi - b]$. Let the tangent of angle $(\alpha_{,} \pm y_{,})$ be (b) and that of $(\alpha - w)$ be (a), then the third side (d) is the distance of the resultant, in tangent of angle. of any two opposite wedges from that of the whole ellipsoid.

Tugonometry gives:

$$d = \sqrt{a^2 - b^2 - 2ab \cos[90° - (\xi - b)]} = \sqrt{a^2 - b^2 - 2ab \sin(\xi - b)}.$$

$$d = \frac{3}{5} n^2E^2 \sin O \cos O \left(1 + \frac{3}{2} E^2 - 2 E^2 \sin^2 O - \frac{4}{7} n^2 E^2 + \frac{23}{20} n^2E^2 \sin^2 O + 2 E^2 \sin^2 O \sin^2 \xi - \frac{81}{70} n^2 E^2 \sin^2 O \sin^2 \xi - 2 E^2 \sin^2 O \sin^4 \xi + \frac{8}{7} n^2E^2 \sin^2 O \sin^4 \xi + \ldots\right).$$

Let $c^2 = 1 + \tan^2(\alpha - w)$.

$f = 1 + \tan^2(\alpha_{,} - y_{,})$.

Let r be the angle that the resultant of any two opposite wedges makes with the resultant of the whole ellipsoid.

Trigonometry gives:

$$\cos r = \frac{c^2 + f^2 - d^2}{2cf}$$

$$\cos r = 1 - \tfrac{9}{50} n^4 E^4 \sin^2 O \cos^2 O \left(1 + 3 E^2 - 4 E^2 \sin^2 O - \tfrac{8}{7} n^2 E^2 + \tfrac{88}{20} n^2 E^2 \sin^2 O + 12 E^2 \sin^2 \xi + 4 E^2 \sin^2 O \sin^2 \xi - \tfrac{81}{35} n^2 E^2 \sin^2 O \sin^2 \xi - 4 E^2 \sin^2 O \sin^4 \xi + \tfrac{16}{7} n^2 E^2 \sin^2 O \sin^4 \xi + \ldots\right).$$

Multiply expression (a) this Art. by the above value for cos r and the expression for the attraction of any two opposite wedges in the direction of the resultant for the whole ellipsoid becomes:

$$\text{Att.} = \frac{M}{D^2}\left(1 - \tfrac{3}{5} n^2 E^2 \cos^2 O + \tfrac{3}{5} n^2 E^2 \sin^2 O \sin^2 \xi - \tfrac{9}{5} n^2 E^4 \cos^4 O - \tfrac{9}{50} n^4 E^4 \sin^2 O \cos^2 O + \tfrac{3}{7} n^4 E^4 \cos^4 O + \tfrac{9}{7} n^4 E^4 \sin^4 O \sin^4 \xi - \tfrac{43}{35} E^4 \sin^2 O \cos^2 O \sin^2 \xi + \tfrac{12}{5} n^2 E^4 \sin^2 O \cos^2 O \sin^2 \xi - \tfrac{183}{175} n^4 E^4 \sin^2 O \cos^2 O \sin^2 \xi + \ldots\right).$$

For the whole ellipsoid per Art. 15

$\sin^2 \xi = \frac{1}{3}$.

$\sin^4 \xi = \frac{3}{2.4.}$. Etc., for higher powers.

---

* Line D extends from attracted particle to center of ellipsoid.

The expression for the whole ellipsoid becomes:

$$\text{Att.} = \frac{M}{D^2}\left(1 - \tfrac{3}{5} n^2 E^2 \cos^2 O + \tfrac{3}{10} n^2 E^2 \sin^2 O - \ldots\right).$$

$$M = \frac{M}{\cos^2 \alpha_{,}} = M\left(1 + \tfrac{1}{2} E^4 \sin^2 O \cos^2 O + \tfrac{1}{2} E^6 \sin^2 O \cos^4 O + \tfrac{5}{8} E^6 \sin^4 O \cos^2 O + \ldots\right).$$

$$\text{b. Att.} = \frac{M}{D^2}\left(1 - \tfrac{3}{5} n^2 E^2 \cos^2 O + \tfrac{3}{10} n^2 E^2 \sin^2 O - \tfrac{3}{5} n^2 E^4 \cos^4 O + \tfrac{3}{7} n^4 E^4 \cos^2 O - \tfrac{9}{35} E^4 \sin^2 O \cos^2 O + \tfrac{9}{5} n^2 E^4 \sin^2 O \cos^2 O + \tfrac{9}{56} n^4 E^4 \sin^4 O - \tfrac{261}{560} n^4 E^4 \sin^2 O \cos^2 O + \ldots\right).$$

$$\text{Att.} = \frac{M}{D^2}\Big[1 - \tfrac{3}{5} n^2 E^2 (1 - \tfrac{3}{2} \sin^2 O) - \tfrac{3}{5} E^4 (n^2 - \tfrac{5}{7} n^4 + \tfrac{3}{5} \sin^2 O - \tfrac{3}{5} \sin^4 O$$

$$-4 n^2 \sin^2 O + 3 n^2 \sin^4 O + \tfrac{137}{70} n^4 \sin^2 O - \tfrac{59}{40} n^4 \sin^4 O) + \ldots\Big]$$

23. To find the increase in attraction in passing on the surface of an oblate ellipsoid from the equator to the poles.

When the attracted particle is at the surface of the Ellipsoid n equals unity and D equals $B_{,}$, and expression (b) Art. 22 becomes

$$\text{Att} = \frac{M}{B^2}\left(1 - \tfrac{3}{5} E^2 \cos^2 O + \tfrac{3}{10} E^2 \sin^2 O - \ldots\right).$$

$$B_{,}^2 = A^2 (1 - E^2 \cos^2 O).$$

$$\text{Att} = \frac{M}{A^2}\left(1 + \tfrac{3}{5} E^2 \cos^2 O + \tfrac{3}{10} E^2 \sin^2 O + \tfrac{3}{35} E^4 \cos^4 O + \tfrac{9}{56} E^4 \sin^4 O + \frac{69}{175} E^4 \sin^2 O \cos^2 O + \ldots\right)$$

$$\text{(a)} \quad \text{Att} = \frac{M}{A^2}\left(1 + \tfrac{3}{5} E^2 - \tfrac{1}{10} E^2 \sin^2 O + \tfrac{3}{35} E^4 - \tfrac{11}{175} E^4 \sin^2 O - \tfrac{1}{200} E^4 \sin^4 O + \ldots\right)$$

At the poles angle O becomes zero, and

$$\text{(b)} \quad \text{Att} = \frac{M}{A^2}\left(1 + \frac{2}{5} E^2 + \frac{2.4}{5.7} E^4 + \text{etc}\right)$$

At the equator angle O becomes ninety degrees, and

$$\text{(c)} \quad \text{Att} = \frac{M}{A^2}\left(1 + \frac{3}{10} E^2 + \frac{3.3}{7.2.4} E^4 + \frac{3.3.5}{9.2.4.6} E^6 + \text{etc.}\right)$$

Subtract expression (a) from (b) and the difference is,

$$\frac{M}{A^2}\left[\frac{1}{10} E^2 \sin^2 O + E^4 \sin^2 O \left(\frac{11}{175} + \frac{1}{200} \sin^2 O\right) + \ldots\right].$$

$$= \frac{M}{A^2}\left[\frac{1}{5} h \sin^2 O + h^2 \sin^2 O \left(\frac{53}{350} + \frac{1}{50} \sin^2 O\right) + \ldots\right].$$

The increase in attraction then from the equator to the poles varies as the square of the sine of the elliptic angle, exact for the second power of excentricity or first power of ellipticity and very nearly true to the sixth power of eccentricity or the third power of ellipticity.

VII.

The gravity and the Figure of a body, due to its Rotation and the attraction of its Component Particles.

First.—The oblate ellipsoid is the figure of equilibrium due to the rotation and attraction of the component particles of a fluid body.

Second.—The increase in gravity from the equator to the poles varies as the square of the sine of the elliptic angle, or the angle with vertex at center of figure, and not as the square of the sine of latitude.

24. To find the combined effect of attraction and rotation on any particle in the plane of the equator of an oblate ellipsoid.

Case 1st. When the velocity of rotation is just sufficient to counterbalance the attraction of the ellipsoid on the particle.

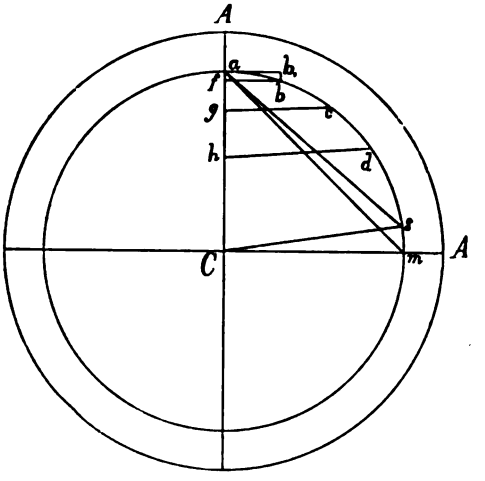


Diagram 10.

In Dia. 10 let a be the particle and let arc a b be the distance of rotation for an infinitesimal unite of time (t) or velocity of rotation. Let a f the versed sine of arc a b in direction A C represent the unite of attraction, also let f a in direction C A represent the repulsive effect of rotation. As attraction just counter-balances repulsion the particle must revolve in the circumference of a circle of radius a C. As attraction and repulsion act at a right angle to an infinitesimal portion of the circumference these forces can neither increase or diminish the velocity (v) of rotation.

Let a f, a g, a h, etc., to a C represent the attraction of the ellipsoid for one, two, three, etc., units of time acting on a particle with a constant force equal to the attraction of the ellipsoid at distance a C. On the circumference lay off arcs a b, b c, c d, etc., to s, each equal to a b; and con-

nect points f b, g c, h d, etc., to C s. By the law of the expedient of this demonstration the time required for particle a to revolve to s acted on by the combined forces is that required for a constant force equal to the attraction of the ellipsoid at distance a C, to move the particle over the distance a C. Let distance a C be represented by (a) and a f by (c). Per law of ultimate ratio tangent a b_1, arc a b and chord a b are equal each to each.

$$\text{Chord } \overline{a\,b}^2 = v^2 = 2\,a \times c. \quad 2\,a = \frac{v^2}{c}$$

$$\text{Chord of a quadrant, } \overline{a\,m}^2 = 2\,a^2 = \frac{a\,v^2}{c}.$$

Per law of *falling bodies:*

$$a = t^2\,c. \quad t = \frac{\sqrt{a}}{\sqrt{c}}$$

$$\overline{a\,m}^2 = v^2\,t^2. \quad a\,m = v\,t.$$

v t is the length of the arc a s, and a m is the chord of a quadrant. The time required for the particle to revolve over the arc a s is $\frac{\sqrt{a}}{\sqrt{c}}$. $\sqrt{2}$ is the length of the chord a m, when $2\,\pi$ is the length of a circumference The time (T) required for a complete revolution of the particle or the rotation of the ellipse is:

$$T = \frac{\pi\,\sqrt{2\,a}}{\sqrt{c}}. \quad T^2 = \frac{2\,a\,\pi^2}{c}.$$

In case of a homogenious oblate ellipsoid, the mass inside of the layer having semi-major axis (a), varies as (a) cubed. The attraction, then, of the ellipsoid on particle (a) in the plane of the equator varies directly as distance (a). As the ellipsoid rotates as one mass the time of revolution of all component particles is the same, and all particles in the plane of the equator rotate without pressure.

Case 2d.—When the repulsion from rotation is not sufficient to counterbalance attraction.

It is evident from case 1st, without further investigation, that the loss of pressure for particle a varies inversely as the time squared of rotation of the ellipsoid to the time of rotation required squared for repulsion to counterbalance attraction.

Case 3d.—When the repulsion from rotation is greater than attraction.

In Dia. 11 let arc a b_1 be the velocity of rotation for an infinitesimal unit of time. The initial impulse of rotation acting alone would throw particle (a) in direction of tangent to distance a b_1, equal to arc a b_1. Let a f be the attraction for the first unit of time. Draw b_1 f′ perpendicular to a C, then a f′ represents the force required acting in direction a C to make the particle revolve in a circle. The versed sine f′ a in direction C a is the

repulsive effect from the rotation measured by the system of a circle. Draw f b perpendicular to a C, and from the initial point a, draw diagonals a b and a $b_{,}$. Under the hypothesis that no component particle excep ing partic'e a, has freedom to change position in the ellipsoid, it is evident that this exceptional particle acted upon by the forces combined would be at the end of the first unit of time at b instead of at $b_{,}$ as it was in Case 1st.

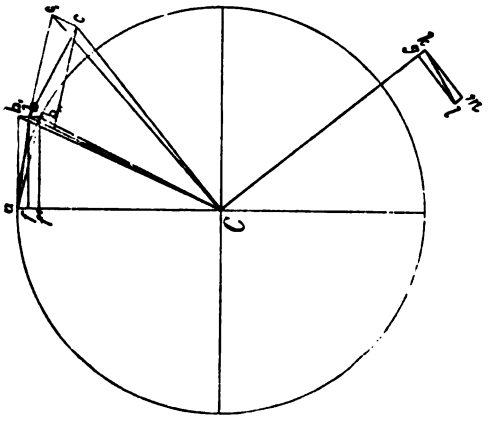


Diagram 11.

If during the second unit of time attraction did not act the particle would continue to move in direction a b to c′ making distance b c′ equal to a b. It is evident under the action of the forces combined at the end of the second unit of time, the particle would be found at some point c in in line c c′ drawn parallel to b C. The position of the particle for the third or any unit of time in due order can likewise be determined.

Triangles C b c and Cbc^1 are equal from having same base Cb and equal altitudes; triangles Cbc^1 and cab are equal from having equal bases bc^1 and ab and same altitude; triangle Cab and $Cab_{,}$ are equal from having same base Ca and equal altitudes. It is now evident that the triangle evolved by the forces combined for any unity of time is equal not only to the one for the first unity of time but also to the one that would be evolved by the initial impulse of rotation combined with an attraction equal to the versid sine due to repulsion from rotation.

Measured, with reference to the arc $ab_{,}$ of the circle attraction is to repulsion as af to f′a, but measured with reference to the arc ab in the path of the particle acted upon by the forces combined attraction and repulsion are equal and in equilibrium in the production of arc ab or any other arc in the path of revolution of the particle.

The following is the enunciation of a proposition well known to be true from demonstration. "If a body describes an ellipse, being continually urged by a force directed towards the focus, that force must vary inversely as the square of the distance." In the case, then, under consideration if

the attraction of the ellipsoid on the particle varied inversely as the square of the distance, the path of revolution would be an ellipse. In Dia. 11, let kl be any part of the elliptic path of revolution described in a unite of time. Take gk to fa inversely as $\overline{Ck}^2$ to $\overline{Ca}^2$, and draw gl and complte the parallelogram kglm. It is evident that the diagonal kl is the resultant effect of attraction kg being equal to the repulsion gk or lm. If the attraction then varied inversely as the cube or any other higher power of distance kg would be shorter than in the case just considered and the diagonal of equilibrium would be a line from k to some point between m and l. With a spherical central body, then, the path of revolution of the particle would be an ellipse, but with an ellipsoidal central body it is otherwise.

In the expression for the attraction of an oblate ellipsoid in the plane of the equator (Art. 22) subtitute (A) divided by (n) for (D) and the expression becomes:

$$\text{Att.} = \frac{M}{A^2}\left(n^2 + \tfrac{1}{2} \times \tfrac{3}{5}\, n^4 E^2 + \frac{3}{2.4} \times \tfrac{3}{7}\, n^6 E^4 + \text{etc.}\right)$$

The sum of the elements $\frac{Mn^2}{A^2}, \frac{3}{10}\frac{Mn^4E^2}{A^2}$ etc., make up the attraction of the ellipsoid. The first element acting alone would cause the particle to revolve in an ellipse; but the other elements acting conjointly would cause it to move in a path continuously increasing the distance from the center of the ellipsoid, or the path would be a spiral evolved by a radius vector increasing continuously in length and also decreasing in angular velocity so as to generate equal areas in equal time. All of these elements combined evolve a resultant path having a radius vector increasing and decreasing during a revolution as the radius vector of an ellipse would increase and decrease while additionally and continuosly receiving increments of length. An appropriate appellation for the resultant path is elliptic spiral. The radius vector of an elliptic spiral generates equal areas in equal time. As far as observation has been able to determine each of the heavenly bodies rotates on an axis; it is, therefore, good common sense to conclude that every body in the heavens revolves in an elliptic spiral orbit continually with decreasing increments departing from its primary. When the particle is an interior one, then its repulsion or outward pressure depends upon the law of the interior attraction of the body.

25. It is evident without additional investigation that the repulsive effect from rotation parallel to the equator, decreases from equator to the poles as A cos O. Angle O is the elleptic angle measured from the plane of the equator.

26. To find the figure of a mass of homogeneous fluid due to rotation and mutual attraction of component particles, also to find the gravity at any point on the surface or within the rotating body.

From the nature of the case the two parts of the rotating fluid body as divided by the equatorial plane are similar and equal, and all sections par-

allel to that plane are circles. The body thus can be conceived, made up in an infinite number of laminæ or layers or shells so that the mass of the body within any layer may vary as the cube of the equatorial radius of the layer. The body can also be conceived, made up of an infinite number of eccentric cones or cones with eccentric bases, having their bases in the surface of the body and their vertices at the center of the equatorial section or center of body. These cones may be taken with such areas of base that their volumes shall vary as distance from base to center of body. In case the body in equilibrium is an ellipsoid, it can be conceived, made up of an infinite number of elliptic cones or cones with elliptic bases. If each elliptic cone has an elliptic base with one principal axis, of length due it per the system of dividing the ellipse extending from either pole of the ellipsoid to the equator per law of alpha or beta elliptic angles (see Art. 14 and Diagram 5), and the other principal axis of length due it from proportional distance from center of the ellipsoid, then the cones have equivolent bases and their volumes vary as distances from bases to center of body. Per the expedient of the layers and the cones, any layer by the cones is conceivably cut up into infinitesimal parts, so that each part has mass proportional to its distance from the center of the body.

Fluid equilibrium, or a state of rest for any and all of the component particles requires that the pressure from any infinitesimal part of a layer on the fluid interior shall just equal that of any other part of same layer having the same layer surface area.

Such ultimate parts of a layer may be called layer elements of mass. As all sections of the rotating fluid body, parallel to the plane of the equator must be circles, and as the equatorial plane must divide the body into two equal parts whatever the figure of a section in a plane of the axis of rotation, a line of layer elements of mass in either polar radius must balance a line of elements in an equatorial radius. It is safe then to take as granted that gravity at either pole to gravity at the equator is inversely as polar to equatorial radii. As the sphere is the figure of equilibrium for a fluid body not rotating, and as a sphere rotated on a center axis generates a centrefugal or repulsive force in lines of ordinates of axis, proportional to lengths of ordinates, and as the oblate ellipsoid is the only figure that has the required relations to the sphere to continue a fluid mass in equilibrium in passing from a state of rest to a condition of rotation, it is safe to take as granted that such is the figure of equilibrium for a rotating ing mass, providing it be demonstrated that every element of mass of a layer presses, each to each, equally on interior mass.

The general expression for attraction on a particle at the surface of an ellipsoid, is:

$$\text{Att.} = \frac{M}{A^2}\left[\ 1+\frac{4}{5}\,h-\frac{1}{5}\,h\sin^2 O+\frac{18}{35}h^2-\frac{53}{350}h^2\sin^2 O-\frac{1}{50}h^2\sin^4 O+h^3\,(\ )+\ \right]$$

To satisfy the conditions the elliptic angle (O) in the above must be meas-

ured from the polar axis. The following is an equivolent expression with the elliptic angle (O) measured from an equatorial radius:

$$\text{Att.}=\frac{M}{A^2}\left[\ 1+\frac{4}{5}\,h-\frac{1}{5}\,h\cos^2 O+\frac{18}{35}h^2-\frac{53}{350}h^2\cos^2 O-\frac{1}{50}h^2\cos^4 O+h^3\,(\ )+\ \right]$$

Let a represent an equatorial radius varying from O to A, then for mass interior to any layer M varies as (a) cube, hence interior attraction varies as a. For iuterior attraction a can be substituted for M divided by A^2. h in the above expression for attraction equals A—B divided by A. To put the expression in shape so that h may represent unity divided by A, the constant terms $1+\frac{4}{5}h+\frac{18}{35}h+$etc., so far as used in the computation must be made unity. The same result is obtained by not making this change, providing due allowances are made for A—B not being equal to unity.

$$\text{Att}=a\,[1-\tfrac{1}{5}\,h\ \cos^2 O\ -\ \tfrac{53}{150}\ h^2\ \cos^2 O-\tfrac{1}{50}\,h^2\cos^4 O-h^3\,(\ )-\ ].$$

The difference in attraction for any point on the polar radius and same layer point on the equatorial radius is:

$$\left(\frac{1}{5}\,h+\frac{6}{35}\,h^2+\frac{4}{35}\,h^3+\ \right)$$

When the rotating fluid body is in equilibrium the mass from a layer in any equatorial cone must just balance the mass from same layer in either of the polar cones. As these masses vary as their distances from the center of the body, gravity in the plane of the equator and in the polar axis must vary inversely as same distances, and the centrifugal force or repulsion from rotation in the plane of the equator must, in case of equilibrium, be expressed by,

$$a\,h-a\left(\frac{1}{5}\,h+\frac{6}{35}\,h^2+\ \right)=a\left(\frac{4}{5}\,h-\frac{6}{35}\,h^2-\ \right)$$

The repulsion from rotation at any point in or on the rotating body in direction parallel to the equatorial plane is per demonstration (Art. 25),

$$\text{Rep.}=a\cos O\left(\frac{4}{5}\,h-\frac{6}{35}\,h^2-\frac{4}{35}\,h^3-\ \right)$$

Gravity is the third side of a triangle in which the two sides (attraction and repulsion of rotation) and the included angle $[(O-z)+(\alpha-w)]$ are given. The third side or

$$\text{Gravity}=\left\{\text{Att.}^2+\text{Rep.}^2-2\ \text{Att.}\times\text{Rep.}\times\text{Cos}\,[(O-z)+(\alpha-w)]\right\}^{\frac{1}{2}}$$

$$\text{Gravity}=a\left[1-h\cos^2 O+\tfrac{1}{2}h^2\cos^2 O-\tfrac{1}{2}\,h^2\cos^4 O+h^3(\ )-\ \right]$$

The expression for any radius of an oblate ellipsoid in terms of ellipticity and sine of elliptic angle (O) in which angle angle (O) is measured from an equatorial radius is:

$$A_{,} = A \left[1 - h \sin^2 O + \tfrac{1}{2} h^2 \sin^2 O - \tfrac{1}{2} h^3 \sin^4 O \pm h^3 (_{,,}) \pm_{,,} \right]$$

For any point ($a_{,}$) on the surface or within the ellipsoid:

$$a_{,} = a \left[1 - h \sin^2 O + \tfrac{1}{2} h^2 \sin^2 O - \tfrac{1}{2} h^3 \sin^4 O + h^3 (_{,,}) -_{,,} \right]$$

The above expressions for gravity and radial distance prove that gravity for all points in the same layer of the ellipsoid varies inversely as distance from point to center of body. To comprehend how this result satisfies the second test for equilibrium in full it must be understood in the expedient of the infinitesimal layers and cones, that the same system of cones is used only to divide up one or any one layer. The point now required to be proven is that when any cone is so moved that its axis is changed to the normal or direction of gravity, without changing the point of base on the layer, the cone cuts the same mass from the layer as when in first position. The expedient used to divide up the layer requires the ellipse to be described with a variable radius with the center fixed at the center of the ellipse. Per law of ultimate ratio the radius is constant in describing an infinitesimal arc. The same ellipse can be conceived described with the same variable radius, and with that radius kept on the normal or indirection of gravify, providing the center so vary in locations that the describing end of the radius be kept on the ellipse to be described. In this case the ellipse is known, because it is the one describ d by the fir-t method. For any point of the curve, then, the center in the normal, or in direction of gravity is known. Per law of ultimate ratio by this method an infinitisimal arc of the ellipse is described with the same constant radius as in first instance, and with a fixed center. The same infinitesimal arc of the ellipse, then, is described by either expedient. Therefore the cone in either position cuts from the same layer the same volume or mass.

A fluid mass takes on a spherical figure from the mutual attraction of component particles. If such spherical body receives an initial impulse of rotation sufficient to cause one complete rotation during infinity of time, then the ultimate ratios initiated for change of figure are those, and those only, that are due to change from a sphere to an oblate ellipsoid. This should be taken as demonstrat on that the oblate ellipsoid is the figure of equilibrium and alone that figure, unless there is real ground for positive proof otherwise.

VIII.

The Figure of Equilibrium, the Density and Temperature of the Earth and Other Planets.

First.—The oblate Ellipsoid is the figure of equilibrium of a rotating fluid mass of heterogeneous density, and all solids manifest the fluid property in some degree under a reqnisite continued pressure.

Second.—The average density of the earth's crust in depth about 130 miles is 2.96 times water, and at the center about 3.05 times that of the crust, or 9 times water. At other points the density is given in table 4, this chapter.

Third.—The temperature of the earth from surface to center at first increases about 1° C. per 90 feet, but this rate of increase so diminishes that at the depth of 130 miles the temperature becomes about 3,600° C. Thence to the center the rate of increase is so small that the temperature continues nearly uniform.

Fourth.—The earth has yet to cotract, radially, about 150 miles to become throughout zero temperature. The interior flames will be, continually, fed by the fuel of pressure of outside load to a limit beyond which the earth's mass cannot compress. The present interior, at a few miles below the surface begins to get plastic, and from about 130 miles below the surface to the center it becomes so plastic that the temperature is kept nearly uniform by convection of heat.

NOTE.—The density of a fluid earth composed, throughout, proportionally of the same elements would increase from surface to center, not withstanding the commotion produced by the heat generated by pressure. In case of such an earth at 15° C., if there were no heat from pressure, and therefore a state of rest, its increase in density would be per law of compression. If heat sufficient to raise the temperature of the whole mass 50° C. were put into such earth so as to leave surface at 15° C., and have the increase in tempergture from surface to center per law of compression, then in case no heat escaped, per law of convection there would be no state of rest till the whole mass became of uniform temperature, 65° C. It is evident, then, that an earth having a crust with moulten interior would be at a state of rest proportionally to the thickness and non-conducting heat property of its crust. Not with-standing the moulton interior of the earth (if she has such) is now at temperature nearly uniform, yet I suppose before the crust solidified or become plastic that heat radiated into cold space so rapidly that in spite of the law of convection, the temperature at the center of the earth was thousands of degrees higher than at the surface. The heighth to which material is now being thrown from the sun, proves that the temperature at his center is higher beyond com-

prehension than at his surface. Let those believing solidification commenced at the center keep these facts in mind while reading this chapter.

27. To find the decrease in attraction on a rotating fluid oblate ellipsoid from the poles to the equator.

Conception 1st. Such an oblate Ellipsoid can be conceived made up of an infinite number of oblate Ellipsoids having a common center, and each component Ellipsoid of homogeneous density.

Conception 2d. The same oblate Ellipsoid can be conceived made up also in shells or layers with each shell or layer of homogeneous density. The surface of the layers in this case would be at the surface of the component Ellipsoids of conception first.

The attraction of each component ellipsoid can be computed by formulae already developed for homogeneous ellipsoids, and the attraction for the heterogeneous mass is equal to the sum of the attractions of the component parts.

The attraction of first or largest component ellipsoid at pole is:

$$\frac{m}{B^2}\left[1-\frac{3E^2}{5(1-E^2)}+\ldots\right]=\frac{m}{A^2}(1+\tfrac{3}{5}E^2+\ldots)$$

The attraction at equator of same is:

$$\frac{m}{A^2}(1+\tfrac{3}{10}E^2+\ldots)$$

Decrease from pole to equator is:

$$\frac{m}{A^2}(\tfrac{1}{10}E^2+\ldots=\frac{m}{A^2}(\tfrac{1}{5}H+\ldots)$$

The attraction at the pole of first ellipsoid for the second component ellipsoid is:

$$\frac{m_1}{B^2}\left[1-\frac{3b^2E^2}{5B^2(1-E^2)}+\ldots\right]=\frac{m_1}{A^2}\left[\frac{1}{1-E^2}-\frac{3a^2E^2}{5A^2(1-E^2)^2}\right]=\frac{m_1}{A^2}$$

$$\left[1+E^2+\ldots-\tfrac{3}{5}n^2E^2+\ldots\right], \text{ in which } n^2=\frac{a}{A^2}.$$

The attraction at equator for same is:

$$\frac{m_1}{A^2}\left[1+\tfrac{3}{10}n^2E^2+\ldots\right].$$

Decrease is:

$$\frac{m_1}{A^2}\left[2H-\tfrac{9}{5}hn^2\pm\ldots\right].$$

Results are thus obtained for all the component ellipsoids.

The decrease in attraction from pole to equator of the heterogeneous oblate ellipsoid or sum of results for component ellipsoid is:

$$\frac{2H}{A^2}(m+m_1+m_2+m_3+\text{etc.})-\frac{9}{5A^2}(mH+m_1n^2h+m_2n_1^2h_1+m_3n_2^2h_2+\text{etc.}).$$

The general expression for the attraction of a homogenous oblate ellipsoid on any outside particle, when modified by the requisite substitutions proves that the decrease in attraction from the equator to the pole of the heterogenous ellipsoid, caused by any of the interior component homogeneous ellipsoid, varies in accordance with the law for a homogeneous oblate ellipsoid, when the attracted particle is at any point on the surface. The decrease in attraction then, from the equator to the pole, true for the second power of eccentricity, varies as the square of the sine of the elliptic angle, or the angle of *geocentric latitude.*

28. To find the decrease in attraction of an oblate ellipsoid on a particle in the surface of any layer from the plane of the equator to a polar radius.

Under the conditions of this discussion, when a heterogeneous ellipsoid becomes homogeneous, then all the layers become similar and of equal ellipticity. The layers of the heterogeneous ellipsoid can be made similar by taking away certain crescent pieces. To determine the attraction on any particle in the surface of any interior layer, the attraction of certain outside crescent pieces and the interior mass need only be considered, as all the other exterior mass attracts the particle equally in opposite directions.

In the last article an expression is developed that can be used to determine the attraction of the interior mass. A method to find the attraction of the crescent pieces become manifest from diagram 4. The attraction on particle P of that portion of the ellipsoid cut out by rotation of the lines Pe and Pg depends upon the length of chord dg or ce, when angle g Pe is small or infinitesimal. The point of tangency a bisects chord d g. The length of chord d g varies as diameter $B_{,}$ $B_{,}$. The diameter $B_{,}$ $B_{,}$ becomes longer by increasing the ellipticity. When point P is moved to the interior of the ellipsoid, that portion of the chord d g, as shown in diagram 2, by Pd, is equal to $gg_{,}$, in case the ellipsoid is composed of similar layers, or is of homogeneous density. If the ellipsoid is composed of layers of decreasing ellipticities or with density increasing from surface to center, then Pd is less than $gg_{,}$. The angle P ax of diagram 4 is a right angle by construction, and PaC is less than a right angle. The angle Cax, or angle α, or the *angle of the vertical* bacomes nothing when the layer, of which a is the point of tangency becomes a circle. When the ellipticity of the ellipse having a in point of tangency is less than that of the ellipse BA BA, then the difference between $gg_{,}$ and Pd of diagram 2, or the attraction for the external crescent pieces is at ained from the expression already obtained for the sine of angle α or the angle of the vertical.

$$\sin \alpha = E^2 \sin \vartheta \cos \vartheta +_{.} = 2 \text{ h} \sin \vartheta \cos \vartheta +_{.}.$$

When point of tangency a, of diagram 4, is in the surface of the layer, and point P is moved in semi axis BC, to the surface of the same layer,

then the radius for the angle α for any direction of chord dg cutting the layer, varies in length from zero to semi axis b. The general expression for any of the radii is, b sin ϑ.

Let E be the eccentricity and H the ellipticity of the outside layer. The expression for the sine of the angle of the vertical for the ellipse having semi minor axis b and eccentricity E is, $\sin \alpha = b\, E^2 \sin^3 \vartheta \cos \vartheta$.

The expression for the sine of the corresponding *angle of the vertical* for a layer having semi minor axis b and eccentricity e is, $\sin \alpha_{,} = b\, e^2 \sin^3 \vartheta \cos \vartheta$.

$$gg_{,} - Pd = 2 \sin \alpha - 2 \sin \alpha_{,}.$$

The expression for any chord of a layer drawn from a pole of the layer is, 2 b cos ϑ.

$$\frac{gg_{,} - Pd}{2\, b \cos \vartheta} = (E^2 - e^2) \sin^2 \vartheta = 2\,(H - h) \sin^2 \vartheta.$$

The attraction of the mass cut from a homogeneous oblate ellipsoid having semi minor axis b and eccentricity e, by any two chords drawn from a pole, the one chord making an infinitesinal angle with the other is:

$$\text{Att.} = \frac{m}{b^2}\left(1 - \tfrac{2}{5} e^2 \sin^2 \vartheta + {}_{,,}\right).$$

The attraction then of the mass cut from the whole ellipsoid having semi minor axis B and eccentricity E by the two chords extended, on a particle at the pole of the interior layer, having semi minor axis b and eccentricity e, providing the density of the whole mass is homogeneous, is

$$\text{Att.} = \frac{m}{b^2}\left(1 - \tfrac{2}{5} e^2 \sin^2 \vartheta + E^2 \sin^2 \vartheta + {}_{,,}\right)$$

To make summation for whole ellipsoid we must put, as hertofore:

$$\sin^2 \vartheta = \tfrac{2}{5}.$$

$$\sin^4 \vartheta = \frac{2,\,4}{5,\,7}, \text{ etc., for higher powers.}$$

For whole ellipsoid as above described, then, on particle at pole of layer:

$$\text{Att.} = \frac{m}{b^2}\left(1 - e^2 + \tfrac{2}{5} E^2 + {}_{,,}\right) = \frac{m}{a^2}\left(1 - O + \tfrac{2}{5} E^2 + {}_{,,}\right).$$

Likewise obtained for particle in equator of same layer:

$$\text{Att.} = \frac{m}{a^2}\left(1 + \tfrac{1}{2} e^2 - \tfrac{1}{5} E^2 + {}_{,}\right).$$

Attraction at pole, then, less that of the equator, is:

$$\text{Dif. of Att.} = \frac{m}{a^2}\left(\tfrac{3}{5} E^2 - \tfrac{1}{2} e^2 + {}_{,}\right) = \frac{m}{a^2}\left[\tfrac{1}{5} h + \tfrac{6}{5}(H - h) + {}_{,}\right].$$

An oblate ellipsoid having semi-minor axis B, and ellipticity H, and density increasing from surface to center can be made up of a homogeneous oblate ellipsoid, having semi minor axis b and ellipticity h, with density the same as layer having semi minor axis b and ellipticity h, and of other homogeneous oblate ellipsoids having semi minor axis less than b and ellipticities less than h, and also an outside part, composed of layers having semi minor axes varying from B to b, with ellipticities varying from H to h.

Let l be the density of the layer having semi minor axis b. For the outside crescent masses there can be substituted one crescent mass of the same volume as the sum of the crescent masses, with a density, so as to give an equivolent attractive effect. Let this density be c times the surface density of the heterogeneous ellipsoid. Let M be the mass of the whole heterogeneous ellipsoid, M the mass of the homogeneous ellipsoid, having density l, and m, m_1, m_2, etc., the masses of the homogeneous ellipsoids having semi minor axis less than b.

It is now evident from investigations already made, that for the surface of any layer, the attraction at the pole of the layer, less that at the equator, can be expressed as follows:

$$\text{Diff. of Att.} = \frac{M}{M}\left[\tfrac{1}{3}\,h + \frac{6\,c}{5\,l}\,(H - h)\right] + \frac{2h}{M}(m + m_1 + m_2 + \text{etc.})$$

$$-\frac{9}{5M}\,(m\,h + m_1\,n^2\,h_1 + m_2\,n_1^2\,h_2 + \text{etc.})$$

The result from the general expression for the attraction of a homogeneous oblate ellipsoid on any outside particle, when the requisite substitutions for the case under consideration are made, proves that the decrease in attraction on the surface of any layer from its pole to its equator varies in accordance with the law for the homogeneous oblate ellipsoid at its surface.

29. To find the figure of equilibrium of a fluid rotating mass, increasing in density from surface to center.

The attraction at the surface of any layer at its equator being less than at its poles, the thickness of any layer at its equator is greater than at its poles. As the decrease in attraction on the surface of any layer varies per law for the surface of a homogeneous oblate ellipsoid, the increase in the thickness of the layer as caused by attraction, must follow the law for the increase in the radii of an oblate ellipsoid. The effect of the centrifugal force to give its additional increase of ellipticity follows for the layer the law for the surface of the homogeneous ellipsoid. The combined effects, then, of attraction and centrifugal force, or gravity, cause each layer to be an oblate ellipsoidal layer, or the figure of equilibrium of all layers to be, also that of an oblate ellipsoid.

30. To find the density of the earth from surface to center, the mean density being $\frac{10}{11}$ times greater than that of a surface layer 127 miles deep.

The increase in the density of liquids caused by pressure, as shown by Oersted's apparatus and other experiments, varies as the pressure, measured under the condition of constant temperature. Gasses follow the same law. Deschanel says, "The true compressibility of water, according to recent experiments conducted under the direction of M. Jamin, by Messrs. Amaury and Descamps, is at the temperature of 15° Centigrade .0000427 per atmosphere." In these experiments the compressibility of glass was taken to be 0000039 per atmosphere. The fact that solids can be compressed shows that solids possess the fluid property essential to compressibility. The fact that rocks are found bent which once were straight, also that a pane of glass or a slab of marble can be bent by a certain continued pressure demonstrates that the particles of solids can move on each other. The movements of solid ice in glaciers is proof in the same direction. The effect of pressure above and below the columns left for supports in deep mines gives like testimony. The deep canyons of Colorado permit the water to cut so deep and no deeper, because below a certain depth the solid rock bottom like putty, rises from weights of high banks.

It is the theory of the geologist that the earth, below a thin solid crust, begins to become plastic, and at certain small depth becomes so plastic that the temperature thence to the center can only slightly increase, owing to the *law of convection of heat.* If the theory of the geologist be true, then the increase in the density of the interior of the earth caused by pressure varies as outside pressure. It is only in the case the theory is not true that we need trouble ourselves about the shadow of a doubt that remains in reference to the law of compressibility of fluids applying to solids.

If computations made by fórmulæ already developed, modified by the condition of the theory of the geologist, builds up the earth from center to surface in layers, giving the difference of gravity of corresponding layer points in polar and equatorial radius in harmony from center to surface and exactly meets the observed difference of gravity at the surface, likewise for ellipticity of layers so as to meet the observed ellipticity at surface, also giving a computed direction for gravity at the surface at any latitude exactly in agreement with the observed direction, then it seems to me it must be accepted that the theory of the geologist is truth, and that the theory of the astronomer, based on computations made from uncertain data is a fallacy.

TABLE I.

1.	2.	3.	4.	5.	6.	7.	8.
No. Layer.	Volume.	Incr. Dens.	Density.	Mass Layers	Mass H.— Ellipsoids.	Ellipticity.	$-\frac{2}{3}$ h n² m.
31	2791	.....	1.0000	2791	29791	$\frac{1}{364}$	—.0032142
30	5048	.12675	1.1267	5687	3421	$\frac{1}{328.2}$	3408
28	4376	.2623	1.3890	6078	5758	$\frac{1}{305.6}$	4875
26	3752	.2876	1.6766	6291	5058	$\frac{1}{312}$	3617
24	3176	.3020	1.9788	6284	4174	$\frac{1}{317.3}$	2501
22	2648	.3012	2.2800	6037	3207	$\frac{1}{323.6}$	1593
20	2168	.2841	2.5641	5559	2272	$\frac{1}{334.9}$	923
18	1736	.2570	2.8161	4888	1469	$\frac{1}{347.5}$	480
16	1352	.2091	3.0252	4090	857	$\frac{1}{360.3}$	220
14	1016	.1613	3.1865	3237	442	$\frac{1}{376.5}$	86
12	728	.1148	3.3013	2403	198	$\frac{1}{391.4}$	28
10	488	.0744	3.3757	1647	74	$\frac{1}{391.7}$	7
8	296	.0430	3.4187	1012	22	.....	1
6	152	.0213	3.4400	523	4.6	.....	.....
4	56	.4083	3.4483	193	.53	.....	.....
2	8	.0020	3.4503	27	.014	.....	.....
....	29791	.....	.....	56747	56747	.....	—.0049881

The numbers in column 1, table 1, represent the polar radii of similar elliptic layers or shells composing an oblate ellipsoid. The numbers in column 2 are the differences between the cubes of 31 and 30, 30 and 28, 28 and 26, etc. As the volumes of similar oblate ellipsoids vary as the cubes of their polar radii, the numbers in column 2 are proportional to the volumes of the component layers. The mean density of the earth as attained by experiments is, at least very nearly, $\frac{40}{11}$ times that at surface. The whole mass of the earth, then, may be represented by 31 cubed multiplied by $\frac{40}{11}$, or 56745, or by 56745 divided by 56745. The first number in column 3 is so assumed as to give the requisite mass in the earth under the law that the increase in compression or density varies as pressure. The other numbers in this column are computed and show the increments in density from layer to layer. The numbers in column 4 are the computed densities of the layers, and those in column 5 divided by 56745, the masses. The pressure of the outside layer compared with that of any other, varies as the attraction of the ellipsoid on the masses of these layers. The increment of density for the pressure of any interior layer is found by multiplying the assumed increment .12675 by the pressure of the interior layer divided by the pressure of the outside layer.

The numbers in column 6, divided by 56745 are the masses of the homogeneous ellipsoids, having radi, 31, 30, 28, etc., composing also the ellipsoid, and these numbers are found by multiplying the cubes of the numbers of column first by those of column third, excepting the first number, which is 31 cubed The numbers in column 7 are explained in connection with table 4.

The formulæ already developed for the attraction of a heterogeneous oblate ellipsoid at the pole less that at the equator, is:

$$\text{Diff. of Att.} = \frac{2H}{A^2}(m + m_{,} + m_2 + \text{etc}) - \frac{9}{2A^2}\ (m\,H + m_{,}\,n^2\,h + n._2\,n_{,}^2\,h_{,} + \text{etc})$$

For the purpose of this computation A, and $m + m_{,} + m_2$ + etc., or M, can each be made unity, and the formulæ put in form as follows:

$$\text{Diff Att}_{,} = 2H - \tfrac{9}{5}\,m\,H - \tfrac{9}{5}\,m_{,}\,n^2\,h - \tfrac{9}{5}\,m_2\,n_{,}^2\,h_{,} - \text{etc.}$$

The numbers in column 8 are the computed results of $-\frac{9}{5}\,m\,H$, $-\frac{9}{5}\,m_{,}\,n^2\,h$ — etc

TABLE II.

1.	2.	3.	4.	5.	6.	7.	8.
No. Layer.	Volume.	Incr. Der.	Density.	Mass Layer.	Mass H. — Ellipsoid.	Ellipticity.	$-\frac{9}{5}\,h\,n^2\,m$
31	2791	.....	1.0000	2791	29791	$\frac{1}{301}$	—.0032142
30	2611	.11867	1.1187	2921	3202	$\frac{1}{298.2}$	3190
29	2437	.1261	1.2448	3033	3075	$\frac{1}{302}$	2827
28	2269	.1326	1.3774	3125	2910	$\frac{1}{305.6}$	2464
27	2107	.1378	1.5152	3192	2712	$\frac{1}{309}$	2112
26	1951	.1415	1.6567	3232	2487	$\frac{1}{312}$	1779
25	1801	.1435	1.8002	3242	2242	$\frac{1}{314.8}$	1469
24	1657	.1436	1.9438	3220	1985	$\frac{1}{317.8}$	1190
23	1519	.1418	2.0856	3168	1725	$\frac{1}{319.8}$	942
22	1387	.1379	2.2235	3084	1468	$\frac{1}{322.6}$	729
21	1261	.1322	2.3557	2970	1224	$\frac{1}{324.4}$	551
20	1141	.1248	2.4805	2830	998	$\frac{1}{324.9}$	406
19	1027	.1160	2.5965	2666	795	$\frac{1}{326.8}$	290
18	919	.1060	2.7025	2483	618	$\frac{1}{327.5}$	202
17	817	.0953	2.7978	2285	468	$\frac{1}{328.5}$	136
16	721	.0842	2.8820	2077	344	$\frac{1}{329.8}$	88
15	631	.0730	2.9550	1864	246	$\frac{1}{330}$	55
14	547	.0622	3.0172	1650	170	$\frac{1}{330.6}$	33
13	469	.0519	3.0691	1439	114	$\frac{1}{331.1}$	19
12	397	.0423	3.1114	1235	73	$\frac{1}{331.4}$	10
11	331	.0338	3.1452	1041	51	$\frac{1}{332}$	6
10	271	.0262	3.1714	859	26	$\frac{1}{332}$	3
9	217	.0197	3.1911	692	14	.....	.....

TABLE II — continued.

1.	2.	3.	4.	5.	6.	7.	8.
No. Layer.	Volume.	Incr. Den.	Density.	Mass Layer.	Mass H. — Ellipsoid.	Ellipticity.	$-\frac{2}{3}$ h n^2 m.
8	169	.0143	3.2054	541	7	.....	.....
7	127	.0100	3.2154	408	3.4	.....	.....
6	91	.0066	3.22 0	293	1.3	.....	.....
5	61	.0041	3.2261	196.8	.5	.....	.....
4	37	.0023	3.2284	119.4	.14	.....	.....
3	19	.0011	3.2295	61.4	.029	.....	.....
2	7	.0004	3.2299	22.7	.003	.....	.....
1	1	.0002	3.2301	3.23	.000	.....	.....
....	29791	.....	.....	56733.53	56750.372	.....	—0050643

Tables 2 and 3 are made on plan of table 1.

$2\,H = \frac{1}{147} = .0068027$.

Table 1 gives: .0068027 − .0049881 = .0018146 for difference in attraction.

Table 2 gives: .0068027 − .0050643 = .0017384 for difference in attraction.

Table 3 gives: .0068027 − .0051030 = .0016997 for difference in attraction.

The difference between first result and second is .0000762, and that of second and third, 0000384. The first difference is about double that of the second. From these differences we can closely estimate what would be the result in case the outside layer be kept of thickness one thirty-first part of radius, and the other layers be reduced to infinitesimal thickness. The result in that case for attraction at pole less that at the equator would be about .001665, or $\frac{1}{600}$.

The observed gravity at the pole, less that at the equator, is $\frac{1}{189}$; and the centrifugal force at the equator is $\frac{1}{289}$, and nothing at the pole. The observed attraction at the pole, less that at the equator, is: $\frac{1}{189} - \frac{1}{289} = \frac{1}{600}$.

I find by computations that a true result for attraction cannot be attained in accordance with observed and known data, and divide the earth, from surface so center into layers infinitesimally thin. To meet that data an outside layer of about

TABLE III.

1.	2.	3.	4.	5.	6.	7.	8.
31	2791	.....	1.0000	2791	29791	[illegible]	—0032142
30	1327⅝	.1151	1.1151	1480	3107	[illegible]	3095
29½	1283⅝	.0620	1.1771	1510	1519	[illegible]	1523
29	1239⅞	.0636	1.2407	1538	1551	[illegible]	1426
28½	1197⅛	.0651	1.2058	1563	1507	[illegible]	1330
28	1155⅛	.0664	1.3722	1585	1457	[illegible]	1234
27½	1113⅞	.0676	1.4389	1603	1406	[illegible]	1142
27	1073⅝	.0685	1.5083	1619	1348	[illegible]	1050
26½	1034⅞	.0693	1.5776	1630	1289	[illegible]	962
26	994⅞	.0698	1.6474	1638	1227	[illegible]	876
25½	956⅝	.0701	1.7175	1642	1162	[illegible]	796
25	918⅞	.0702	1.7877	1642	1097	[illegible]	719
24½	882⅛	.0700	1.8577	1638	1029	[illegible]	645
24	846⅛	.0696	1.9273	1630	962	[illegible]	576
23½	810⅞	.0689	1.9962	1618	894	[illegible]	512
23	776⅝	.0680	2.0642	1602	827	[illegible]	452
22½	742⅝	.0669	2.1311	1582	762	[illegible]	397
22	709⅝	.0655	2.1966	1558	697	[illegible]	346
21½	677⅝	.0639	2.2605	1530	635	[illegible]	300
21	645⅞	.0623	2.3228	1500	577	[illegible]	260
20½	615⅛	.0602	2.3830	1465	518	[illegible]	222
20	585⅛	.0581	2.4411	1428	465	[illegible]	189
19½	555⅞	.0558	2.4969	1388	413	[illegible]	159
19	527⅝	.0534	2.5503	1345	366	[illegible]	133
18½	499⅝	.0509	2.6012	1299	322	[illegible]	111
18	472⅝	.0483	2.6495	1252	281	[illegible]	92
17½	446⅝	.0450	2.6951	1203	244	[illegible]	75
17	420⅞	.0429	2.7380	1152	211	[illegible]	61
16½	3 6⅛	.0402	2.7782	1100	180	[illegible]	49
16	372⅛	.0375	2.8157	1048	153	[illegible]	39
15½	348⅞	.0348	2.8505	994	129	[illegible]	31
15	326⅝	.0322	2.8827	941	108	[illegible]	24
14½	304⅝	.0297	2.9124	887	90	[illegible]	19
14	283⅝	.0272	2.9396	834	74	[illegible]	14
13½	262⅝	.0248	2.9644	781	61	[illegible]	11
13	243⅞	.0224	2.9868	728	49	[illegible]	8
12½	225⅛	.0202	3.0070	677	39	[illegible]	6
12	207⅛	.0182	3.0252	627	31	[illegible]	4
11½	189⅞	.0161	3.0413	577	24	[illegible]	.....
11	173⅝	.0143	3.0556	530	19	[illegible]	.....
10½	157⅝	.0126	3.0682	484	15	[illegible]	.....
10	142⅝	.0109	3.0791	439	11	.....	.....
9½	128⅝	.0095	3.0886	396	8	.....	.....
9	114⅞	.0081	3.0967	356	5.9	.....	.....
8½	102⅛	.0069	3.1036	317	4.2	.....	.....
8	90⅛	.0058	3.1094	281	3	.....	.....
7½	78⅞	.0048	3.1142	246	2	.....	.....
7	68⅝	.0040	3.1182	213	1.37	.....	.....
6½	58⅝	.0033	3.1215	183	.90	.....	.....
6	49⅝	.0026	3.1241	155	.56	.....	.....
5½	41⅝	.0020	3.1261	129	.33	.....	.....
5	33⅞	.0016	3.1277	106	.20	.....	.....
4½	27⅛	.0011	3.1288	84.9	.10	.....	.....
4	21⅛	.0008	3.1296	66.1	.05	.....	.....

TABLE III — continued.

1.	2.	3.	4.	5.	6.	7.	8.
3½	15½	.0006	3.1302	49.7	.03	.....	.....
3	11⅔	.0004	3.1306	35.6	.01	.....	.....
2½	7⅔	.0002	3.1308	23.8	.....	.....	.....
2	4⅔	.0001	3.1309	14.5	.....	.....	.....
1½	2⅔	.....	3.1309	7.3	.....	.....	.....
1	⅔	.....	3.1309	2.7	.....	.....	.....
½	⅓	.....	2.1310	.4	.....	.....	.....
.....	29791	.....	.....	56745	.....	.....	—00510.0

TABLE IV.

No. L.	Mass Layer.	Mass H. E.	Den. s.	Cres. D.	Cen. Force	Att.	Gravity.	Polar Radii.	Equatorial Radii.	Ellipticity.
1	2	3	4	5	6	7	8	9	10	11
31	2791	29791	1.00	1.00	1/280	1/598	1/19.8	3950.0000	3963.5136	1/332.3
30	3058	6235	1.11	1.05	1/308.8	1/678	1/20.6	3822.5806	3835.4641	1/332.3
29	3168	3026	1.24	1.11	1/314.7	1/718	1/21.8	3695.1612	3707.4496	1/332.3
28	3250	2787	1.37	1.16	1/320.9	1/738	1/22.0	3567.7418	3579.4618	1/332.3
27	3303	2542	1.50	1.21	1/324.9	1/798	1/24.0	3440.3224	3451.4991	1/332.3
26	3326	2265	1.64	1.26	1/335.8	1/837	1/24.8	3312.9030	3323.5579	1/332.3
25	3316	1997	1.78	1.31	1/367.6	1/875	1/25.8	3185.4836	3195.6365	1/332.3
24	3274	1719	1.91	1.35	379	911	1/26.6	3058.0642	3067.7319	1/332.3
23	3198	1449	2.04	1.38	1/388.8	945	276	2930.6448	2939.8425	1/332.3
22	3091	1196	2.17	1.42	1/399.6	978	284	2803.2254	2811.9667	1/332.3
21	2960	968	2.29	1.45	1/409.1	1008	291	2675.8060	2684.1058	1/332.3
20	2802	768	2.40	1.48	1/417.6	1036	1/297.6	2548.3866	2556.2521	331
19	2622	591	2.51	1.50	1/424.6	1062	1/303.6	2420.9672	2428.4080	1/332.3
18	2427	446	2.60	1.52	1/431.6	1083	1/308.6	2293.5478	2300.5725	1/332.3
17	2220	323	2.87	1.43	1/437.8	1104	1/313.8	2166.1284	2172.7420	1/332.3
16	2006	226	2.76	1.54	1/442.8	1121	1/317.8	2038.7090	2044.9179	1/332.3
15	1791	157	2.82	1.55	1/446.6	1138	1/320.6	1911.2896	1917.0977	1/332.3
14	1589	103	2.87	1.56	1/450.2	1145	323	1783.8702	1789.2810	1/332.3
13	1374	71	2.91	1.57	1/453.2	1156	1/326.7	1656.4508	1661.4675	1/332.3
12	1175	41	2.95	1.57	1/455.6	1162	1/327.4	1529.0314	1533.6557	1/332.3
11	989	22	2.98	1.57	1/457.5	1169	1/328.9	1401.612	1405.8479	1/332.3
10	813	11	3.00	1.57	459	1174	330	1274.1926	1278.0406	1/332.3
9	656	6	3.02	1.57	1/460.2	1179	331	1146.7732	1150.2347	1/332.3
8	513	4	3.03	1.57	1/460.8	1182	1/331.6	1019.3538	1022.1294	1/332.3
7	385	1	3.04	1.57	1/461.2	1183	1/331.8	891.9344	894.6247	1/332.3
6	276	.....	3.04	....	1/461.6	1183	1/332.2	764.5150	766.8203	1/332.3
5	186	.....	3.05	....	462.8	1183	1/332.6	637.0956	639.0165	1/332.3
4	113	.....	3.05	....	462.8	.....	.....	.....	.....	.....
3	58	.....	3.05	....	462.8	.....	.....	.....	.....	.....
2	21	.....	3.05	....	462.8	.....	.....	.....	.....	.....
1	3	.....	3.05	....	462.8	.....	.....	.....	.....	.....
...	56745	56745	...	...	.....	.....	.....	.....	.....	.....

130 miles thickness must be kept intact, while the interior layers are made infinite in number. This shows that the law of compressibility is inapplicable to the crust on account of increase in temperature, while it is applicable to the interior from uniformity of temperature.

The numbers in column 2, table 4, divided by 56745 are the proportional masses composing the earth taken in thirty-one layers, the outside layer having an assumed average density of unity, or 2.96 times that of water, the mean density of the earth being 5.65 times that also of water. The other layers have masses the same as if earth were taken in layers infinitesimally thin. The numbers in column 3, divided by 56745 are the proportional masses of thirty-one ellipsoids composing the earth under conditions explained for second column. The first number in column 4 is the average density of layer 31, and the other numbers of the column taken in order are the densities at division surfaces between the layers The fractions in column 6 represent the quotients of centrifugal force divided by attraction at the surface of each layer. These results are easily attained, the one at the surface of the earth and the masses of layers being known.

Column 9 gives the polar radii of the thirty-one layers, the polar radius of the earth being about 3,950 miles.

The formulæ already developed for the attraction at the pole of any layer less, that at the equator is:

$$\text{Dif. Att.} = \frac{M}{M}\left[\tfrac{1}{3}h + \frac{6c}{5l}(H-h)\right] + \frac{2h}{M}(m + m_{,} + \text{etc.}) - \frac{9}{M}(mh + m_{,}\, n^2 h_{,} + \text{etc.})$$

The values for c are given in column 5. These numbers are easily computed when the densities and the ellipticities of the layers are known. Before making Table 4, I had so unraveled its net-work by a system of assumptions and corrections that I knew to a close approximation each result. The values for l are given in column 4. M of the formulæ for the surface of any layer is found by adding numbers in column 2 from layer 1 to the layer required inclusive. *M* equals M less the sum of numbers in column 3 not inclusive of the required layer, m, $m_{,}$, m_{2}, etc., are given in column 3. For the surface of any layer H equals $\frac{1}{294}$, and for any layer from 1 to 5 *M* equals M, l equals 3.05; c, 1.57; and m, $m_{,}$, etc., are each zero. For the fifth layer the fraction for ellipticity equals that for gravity; and the fraction for gravity equals the sum for attraction and centrifugal force, For fifth layer, then,

$$g = h = \tfrac{1}{3}h + \frac{1.57 \times 6}{3.05 \times 5}\left(\tfrac{1}{294} - h\right) + \tfrac{1}{462.8} = \tfrac{1}{332.36}.$$

Equatorial radius $= 637.0956 \times \frac{333.6}{331.6} = 639.0165.$

For layer sixth:

$h_{,} = \frac{1}{333.66}$, $c = 1.57$, $l = 3.04$. Assume $\frac{1}{332.63}$ for h.

Computation now gives for attraction $\frac{1}{1158}$, $g = \frac{1}{1152} + \frac{1}{2461.5} = \frac{1}{512.11}$. Average g for the layer equals a trifle less than $\frac{1}{2}$ ($\frac{1}{512.56} + \frac{1}{255.13}$ or $\frac{1}{341.11}$. Equitorial radius of sixth layer less that of fifth equals $127\ 4194 \times \frac{341.1}{342.1} =$ 127 8038, or equitorial radius of sixth layer is 766.8203 miles. The polar and equitorial radii now found for sixth layer tests the assumption for ellipticity. Thus the process is continued from layer to layer in order.

For the surface of the earth, Table 4 gives attraction $\frac{1}{258}$, gravity $\frac{1}{191.5}$ and ellipticity $\frac{1}{293.3}$. It is accepted that attraction is $\frac{1}{600}$, gravity $\frac{1}{193}$ and ellipticity $\frac{1}{294}$. It is accepted also that the mean density of the earth is 5.65 times that of water, and that the surface crust density is not far from one-half of the mean. Further, it is accepted that a fluid of uniform temperature is compressed directly as applied pressure. Table 4 is made up in accordance with these known facts, making a due allowance for an increase in crust temperature. It seems reasonable, then, to accept the results of the *Tables*.

The expression already developed for the sine of the angle made by radial direction with the direction of attraction is, $\frac{2}{5}$ h n^2 m sin O cos O. Columns 8, of Tables 1, 2 and 3, gives the values for $\frac{2}{5}$ h n^2 m. From these results the direction of attraction at any point on the surface of the earth is, $.005137 \times \frac{2}{5}$ sin O cos O. When angle O becomes 45°,

$$.005137 \times \tfrac{2}{5} \sin O \cos O = .001712.$$

At 45° the centrifugal force changes the direction of attraction:

$$\tfrac{1}{2} \times \tfrac{1}{289} = \tfrac{1}{578} = .001730.$$

The direction of gravity or of normal thus computed is:

$$.001712 + .001730 = .003442.$$

The direction of the normal for 45° is:

$$\tfrac{1}{294} = .003401.$$

The error is $\frac{1}{86}$, while the limit of error in the results attained by experiments for the mean density of the earth, or the ratio of surface density to mean is a fraction greater than this. The tables can be adjusted to meet the discrepancy $\frac{1}{86}$, but it would add nothing to accuracy as long as the accepted results of observation are equally uncertain.

To one now doubting the theory of the geologist, I have to say in due time, I shall give him a result for the precession of the equinoxes, computed from the data of *Table* 4. agreeing with observation.

The one effect of the attraction of the sun and moon on the earth wholly liquid, is changeable figure; the other effect on the earth wholly solid, is precession of equinoxes. The effect of the attraction on the particles of a liquid or solid just filling the solid unyielding crust container is the same. To be otherwise the container must instantaneously yield to certain changes of figure due certain effects of the attraction on the particles of the enclosed liquid. In such event the container has the liquid property and from the logic of the astronomer there should be no precession.

The component of the moon's attraction that produces the ocean tides, is only a small fraction of the whole, and this component decreases to nothing at the center of the earth. The slowness of the action of this component force and the cohesion of the particles of water are such that the tide at any meridan does not appear till two hours after the moon has passed that meridan. If the tidal work was done instantaneously the tide would appear directly under the moon. A less component of attraction and a greater cohesion of particles results in slower tidal work. Such a decrease in the component attractions and such an increase in the cohesion of the particles from the surface of the earth to its center can be conceived from which the tidal effects would be wholly neutralized. It is at least evident in case of days of one hour instead of twenty-four, supposing no change of figure from change of rotation, that the ocean tides would glide to the condition of no tides as effectually as a boy slides over a thin scale of ice. The astronomer seems to have forgotten that it takes time to break ice. What is true of a water ocean and days of one hour is true of a plastic ocean and days of twenty-four hours. A crust that would be perceptibly flexible if the day were a month, might be imperceptibly so for a day of twenty-four hours. In case then, of the one hundred and twenty seven miles of solid rock crust and the plastic moulten interior what more could be reasonably expected for tides on the continents than infinitesimal vibrations.

31. The density or specific gravity of the original crust of the earth at the temperature of 0 Centigrade.

The order of evolution is from a condition of homogeneity to that of heterogeneity. To meet the results of the requisite test observations and experiments, the computations of the last article require the plastic interior of the earth to be homogeneous excepting the effect from the variation of pressure. That portion of the primitive crust not yet disintegrated by the action of water or otherwise is likewise homogeneous, and the results of the best investigations point it out to be a neutral rock, largely basic, such a rock as would be formed from the disintegrated material, not including the elements gathered in from the pristine heterogeneous atmosphere. Lyell, in speaking of trappean or volcanic rocks, says: "Abich has, therefore, proposed that we weigh these rocks in order to appreciate their composition in cases where it is impossible to separate their component minerals. Thus basalt from Staffa, containing 47.80 per cent of silica, has a specific gravity of 2.95; whereas trachyte, which has 66 per cent. of silica, has a sp. gr. of only 2.68; trachytic porphyry, containing 69 per cent. of silica, a sp. gr of only 2.58. If we take a rock of intermediate composition, such as that prevailing at the Peak of Teneriffe, which Abich calls Trachyte-dolerite, its proportion of silica being intermediate, or 58 per cent. it weighs 2.78." On this principal a trappean rock thrown up from a depth of 88 per cent. of silica would have a specific gravity of 3.12.

For each degree Centigrade granite expands in volume .000026, marble

.000030, and French glass .000026. In using either of these fractions for primitive crust rock the margin of error is doubtless not large.

Deschanell says the compression for glass per atmosphere is about .0000029. Using for apparatus the moon and Mars instead of Oersted's Piezometer in experiment on the moon's crust and the crust of Mars, instead of on a piece of glass, I find crust rock material is compressed .0000037 per atmosphere. To one understanding the conditions, the results disagree within the limits of a good corroboration of the reliability of the apparatus.

Using for expansion .00003, and for compression .0000037, the computed temperature at 127 miles below the surface of the earth is about 3600° C. Per observations near the surface the increase in temperature is about one degree Centigrade in 90 feet, or 58 degrees in a mile. The average temperature of the crust, then, can not be far from 2500° C. The crust, then, in cooling to zero would contract about seven and one half per cent. This would make the density or specific gravity of crust rock about 3.20.

Lyell's table for "Analysis of Minerals most abundant in Volcanic and Hypogene Rocks," gives the following specific gravities: Hornblende-Faymont, in diorite, 3.20; Hornblende-Etna, in volcanic, 3.01; Uralite-Ural, 3.14; Angite-Bohemia, 3.35; Angite-Vesuvius, in lava, 3.25; Diallage-Hartz, in Gabbro, 3.23; Hypersthene-Labrador, 3.39; Bronzite-Greenland, 3.20, Olivite Carlsbod, in basalt, 3.40; Olivite-Mt. Somma, 3.33. The metals are developments from the disintegrated portion of the primitive crust. Duly considered in all directions it seems not unreasonable that crust rocks have a specific gravity of 3.20 at zero Centigrade.

32. *The interior density and temperature of the moon.*

The moon is admitted to be the direct and the only satellite offspring of the earth, and under the accepted law of its evolution, positive evidence is required to prove its component materials in like proportions, to vary from those of the earth. The mean density of the moon is about three fifths that of the earth, or 3.38 times that of water. In accordance with the method used in computing the interior density of the earth, to keep up a suitable degree of consistency and harmony with known facts, a crust or outside layer density of 3.20 must be used. If the mean density, 3.38, be a trifle small, or the surface density, 3.20, a little large, the remedy is to increase the factor .0000037 for compression, or to freeze the moon to 100 or more degrees below zero. As the factor .0000037 satisfies the conditions of Mars, that factor should not be changed. The freezing out process, then, is the only antidote. Computation gives the center density of the moon 3.52. The compression for a twenty-seven miles crust, or for about, 2,320 atmospheres, is .0086, or .0000037 per atmosphere.

It may be that the water and the air of the moon, chemically, have not yet wholly found quiet resting places, and here and there in its interior chemical action is generating heat. Doubtless, however, the moon, to the center, is solid, practically dead and colder than ice.

33. *The interior density and temperature of Mars.*

Newcomb says the mean density of Mars is 4.17 times water. Using 3.20 for the crust, the center density figures out 5.10. The compression for a fifty-six miles crust, or about 11000 atmospheres is .041, or .0000037 per atmosphere. These results are claimed to be only rough approximations. From them, nevertheless, it is doubtless safe to conclude that Mars is a solid to the center, that his interior heat has nearly all escaped. and that the water and the air has been considerably absorbed in the interior of the planet.

34. *The interior temperature of the earth.*

The variation in the density of the earth from surface to center is given in Table 4. which has already been described. The conditions of this table require that the temperature of the interior layers be the same, which would be practically so in case of a moulten or liquid interior per law of convection. The compression for the one hundred and twenty-seven miles crust, or about 60000 atmosphere on the interior at temperature zero, should be .0000037 multiplied by 60000, or .222. The compression for the same crust of the earth in its presents condition given in Table 4 is only .11, or computed to three decimal places is .114. The difference .108 is caused by internal heat. This difference, .108 divided by .00003 gives the interior temperature to be 3600° Centigrade.

34. Interior density and temperature of Venus.

Newcomb gives 4.81 for the mean density of Venus, and 7,660 miles for her mean diameter or 258 miles less than the mean diameter of the earth, On the hypothesis that Venus has a moulten interior and a crust about the thickness of that of the earth, by using 3 for the crust density we get the required mass into the planet with a center density of 7, and a crust compression factor of .0913. The compression for one hundred and twenty three miles crust or about 49,000 atmospheres is at temperature zero .1813. The difference between .1813 and .0913 divided by .00003 gives for the interior temperature of Venus 3000° Centigrade. Per Newcomb the gravity on the surface of Venus is .82, Mars .39, Earth 1.

35. *The interior density and temperature of Mercury.*

Mercury has a mean density, per Newcomb, 6.85, and a diameter of about 3000 miles, and also a surface gravity .46. The Moon's diameter is 2160 miles, mean density 3.38. crust density 3.20 and center density 3.52. Mars diameter is 4211 miles, mean density 3.17, surface density 3.20, center density 5.10, and surface gravity .39.

Without computation judging by a glance from the figures from the Moon and Mars, the crust density of Mercury must be from 5 to 5.50. Proctor thinks that 6.85 is too great for the mean density, and that it should be about that of the earth, 5.65. Under this condition Mercury's crust density would be from 4 to 4.30. The smallness of the diameter of this planet indicates that its interior heat has all or nearly all escaped. In

case its interior heat has not escaped the figures above given for crust density must be made larger.

36. The crust density of Jupiter's satellites.

The diameters of Jupiter's satellites in orders of Nos. per Loomis is in miles, 2436, 2187, 3576 and 3057. There is some uncertainty about these diameters, and Newcomb says they vary from 2200 to 3700 miles. The mean densities of these satellites in order, per diameters of Loomis is, 1.05, 1.90, 1.70 and 1.32. The averages of these mean densities is 1.49, or a little more than the mean density of Jupiter, which is 1.38. The surface gravity of these satellites is very small, hence the center density can not be very much greater han the crust density. The average crust density can not vary much from 1.30.

37. As already obtained, the near surface or crust density of Mercury is about 5, Venus at present average temperature, 3, or at zero 3.20, the Earth at present average temperature, 2.96, or at zero 3.20, the Moon at zero 3.20, Mars at zero 3.20, and the average of Jupiter's satellites 1.20. From these results I see away back in the past a large ring around the sun; this ring separated into three, like the rings now around Saturn; and from these three came the triplet planets, Mars, the Earth and Venus.*

CONCLUSION.

During the delay of two years in the publication of this Report of the Academy of Sciences, Arts and Letters, I have added three chapters to this paper. As it stands the title is inappropriate, and the introduction fails to give due credit to the paper as presented. *The Attraction and the Figure of Equilibrium of a Rotating Fluid Mass, and the Interior Density and Temperature of the Earth,* is a more appropriate title. Measured by my reading of what has been written on the subject, this investigation attains not only some new final results, but it opens, by its new methods, a new field for valuable deductions. The new way of finding any diameter of the ellipse is a change from the complex to the simple. The system using chord and wedge elements of attraction instead of shell elements is a grand step of advance in simplification. By the new system mathe-

* It is due the author to say that the chapters of this paper were written at periods separated by months. The last chapter was composed after the previous ones had passed from his hands, and he was forced to keep up the connection with the other chapters, partially from memory. His excuse for not unifying the paper under an appropriate title is want of time.

matical expressions are attainable, easy to integrate, while by the old method complex expression are unavoidable, requiring the ability of a Legendre, a Laplace, or an Ivory to integrate.

In Article 12 I have given the fractional numbers for integrating the chord elements of attraction for an ellipsoid. If every man and women, from Adam and Eve to the last born of their posterity, had been engaged in the work of making the computations for these fractional numbers by the method outlined in Article 12, the end in view would now be unattained. Such being the impossibility in the way of that method, I will now give my other method in brief. It is as follows:

In diagram 1, Art. 3, let particle P be at the surface of the sphere having center C, in line P C of the diagram, then secant line P d a g becomes chord P a g and equals to chord k l h or $2\,r \cos \vartheta$. Likewise chord p n o equals $2\,r \cos \vartheta$. Let radius A C perpendicular to the axis of rotation be divided into n parts by a system of chords drawn parallel to axis P C, and also let these chords vary in length from chord to chord by a common difference 2 r divided by n. Let lines p n o and k l h be any two adjoining chords of the system. The mass cut from the sphere by a rotation of these chords equals $\frac{4}{3}\,\pi\,r^3\,(\cos^3\vartheta - \cos^3\vartheta_1)$. As the increments to the cosines used in this computation vary from cos. to cos. as 2 r divided by n, cos. ϑ may be represented by any simple variable quantity (y). When n becomes infinite or 2 r divided by n, infinitisimal, then the differential mass or,

$$dm = \tfrac{4}{3}\,\pi\,r^3\,3\,y^2\,dy.$$

Multiply each chord element of mass making up the sphere by its requisite $\cos\vartheta$, $\cos^2\vartheta$, $\cos^3\vartheta$, and so on to cos. having an exponent infinite. It is now required to intigrate the expressions y d m, y^2 d m, y^3 d m, etc., between the limits zero and unity.

$$\int_0^1 y\,dm = \tfrac{4}{3}\,\pi\,r^3 \int_0^1 3\,y^3\,dy = \tfrac{4}{3}\,\pi\,r^3 \times \tfrac{3}{4}.$$

$$\int_0^1 y^2\,dm = \tfrac{4}{3}\,\pi\,r^3 \int_0^1 3\,y^4\,dy = \tfrac{4}{3}\,\pi\,r^3 \times \tfrac{3}{5}.$$

$$\int_0^1 y^3\,dm = \tfrac{4}{3}\,\pi\,r^3 \int_0^1 3\,y^5\,dy = \tfrac{4}{3}\,\pi\,r^3 \times \tfrac{3}{6}.$$

Etc., to exponent infinite.

$\frac{4}{3}\pi r^3$ represents the mass of the whole sphere. The values, then, for

$$\text{Cos. } \vartheta = \tfrac{3}{4}.$$
$$\text{Cos.}^2 \vartheta = \tfrac{8}{5}.$$
$$\text{Cos.}^3 \vartheta = \tfrac{3}{6}, \text{ etc., to cos. with exponent infinite.}$$

$$\text{Sin}^2\vartheta = 1 - \cos^2\vartheta = \tfrac{3}{4}.$$
$$\text{Sin}^4\vartheta = (1-\cos^2\vartheta)^2 = 1 - 2\cos^2\vartheta + \cos^4\vartheta = \tfrac{3}{8}\tfrac{1}{4}.$$
$$\text{Sin}^6\vartheta = (1-\cos^2\vartheta)^4 = 1 - 4\cos^2\vartheta + 6\cos^4\vartheta - 4\cos^6\vartheta + \cos^8\vartheta = \tfrac{3}{2}\tfrac{1}{7}\tfrac{1}{6}.$$

Etc. for higher powers.

The truth contained in the celebrated proposition of the square of the hypothenuse was doubtless well known long before the time of Pythagoras. Pythagoras in joy from the simplicity and the exactness of his demonstration of the celebrated proposition gave exclamation to the Greek word, *Eureka.* The memoirs of Legendre, Laplace and Ivory on *attraction* do not contain *Eureka* demonstrations. It requires inventive genius as well as mathematical ability to make such demonstrations. For borrowed knowledge on the subject of my writing to Sir Isaac Newton, I am indebted more by far than to all the rest combined.

Genera of the Family Attidae:

WITH A PARTIAL SYNONYMY.

BY

GEORGE W. AND ELIZABETH G. PECKHAM.

INTRODUCTION.

n the following paper we have endeavored to bring to-
her the definitions of those genera of the family Attidae
ich have been generally received, and also of those which
part of the synonymy of the received genera. Up to this
e these definitions have been so widely scattered through
ferent works and periodicals that it has been a matter of
at practical inconvenience to study and to compare
m. It is probably due, in a measure, to this fact that
ny species have been placed in genera from which a mod-
te regard for the generic definitions would have excluded
m; although perhaps a further difficulty may have arisen
m a confusion of the two modes of classification, the one
ed on a type, and the other based on a general definition.
make clear the distinction between these two modes, we
te from Whewell[1], "Natural groups given by type, not
definition . . . . . the class is steadily fixed, though
precisely limited; it is given, though not circumscribed;
s determined, not by a boundary line without, but by a
tral point within; not by what it strictly excludes, but by
at it eminently includes; by an example, not by a pre-
t; in short, instead of a definition we have a *type* for our
ector. A type is an example of any class, for instance, a
cies of a genus, which is considered as eminently possess-
the character of the class. All the species which have
reater affinity with this type-species than with any other,
m the genus and are ranged about it, deviating from it in
ious directions and different degrees." On the other side
have from Mill:[2] " . . . . . the next step is to ar-

[1] The Philosophy of the Inductive Sciences, Vol. 1, pp. 476, 477.

[2] A System of Logic, pp. 504, 505. Huxley, also says: "It is said, in
rt, that a natural history class is not capable of being defined — that
class Rosaceæ for instance, or the class Fishes, is not accurately and

range those *infimae species* into larger groups . . . . . and in doing this it is true that we are naturally and properly guided, in most cases at least, by resemblance to a type. . . . . But though the groups are suggested by types, I cannot think that the group, when formed, is *determined* by the type; that in deciding whether a species belongs to the group, a reference is made to the type and not to the characters. . . . . The truth is, on the contrary, that every genus or family is framed with distinct reference to certain characters, and is composed, first and primarily, of species which agree in possessing all those characters. To these are added, as a sort of appendix, such other species, generally in small number, as possess *nearly* all the properties selected; wanting some of them one property, some another, and which, while they agree with the rest *almost* as much as those agree with one another, do not resemble in an equal degree any other group. Our conception of the class continues to be grounded on the characters; and the class might be defined, those things which *either* possess that set of characters, *or* resemble the things that do so, more than they resemble anything else. And this resemblance itself is not, like resemblance between simple sensations, an ultimate fact unsusceptible of analysis. Even the inferior degree of resemblance is created by the possession of common characters. . . . . *Nor can there be any real difficulty in representing, by an enumeration of characters,* the nature and degree of the resemblance which is strictly sufficient to include any object in the class. There

---

absolutely definable, inasmuch as its members will present exceptions to every possible definition; and that the members of the class are united together only by the circumstance that they are all more like some imaginary average race or average fish, than they resemble anything else. But here, as before, I think the distinction has arisen entirely from confusing a transitory imperfection with an essential character. So long as our information concerning them is imperfect, we class all objects together according to resemblances we *feel*, but cannot *define*; we group them around *types*, in short. Thus, if you ask an ordinary person what kind of animals there are, he will probably say beasts, birds, reptiles, fishes, insects, etc. Ask him to define a beast from a reptile and he cannot do it; but he says, things like a cow or a horse are beasts, and things like a frog or a

are always some properties common to all things which are included. Others there often are, to which some things, which are nevertheless included, are exceptions. But the objects which are exceptions to one character are not exceptions to another; the resemblance which fails in some particulars, must be made up for in others. The class, therefore, is constituted by the possession of *all the characters which are universal,* and *most* of those which admit of exceptions. If a plant had the ovules erect, the stigmata divided, possessed the albumen, and was without stipules, it possibly would not be classed among the Rosaceæ. But it may want any one, or more than one, of these characters, and not be excluded. The ends of a scientific classification are better answered by including it. Since it agrees so nearly, in its known properties, with the sum of the characters of the class, it is likely to resemble that class more than any other in those of its properties which are still undiscovered."

A further confusion has arisen from certain authors making their generic definitions descriptive rather than comparative. For example, the definition of the genus Maratus Karsch is doubtless a good description, so far as it goes, of the species for which the genus was formed, and yet is equally applicable to many other genera, and in no way assists in organizing knowledge, nor in facilitating identification, which should be the two-fold purpose of a classification.

The synonymy of the genera is only partial; and those who have had most experience in the difficulties of this

---

lizard are reptiles. You see *he does* class by type, and not by definition. But how does this classification differ from that of the scientific zoologist? how does the meaning of the scientific class-name of "Mammalia" differ from the unscientific of "Beasts?" Why, exactly because the former depends on a definition, the latter on a type. The class Mammalia is scientifically defined as "all animals which have a vertebrated skeleton and suckle their young." Here is no reference to type, but a definition rigorous enough for a geometrician, and such is the character which every scientific naturalist recognizes as that to which his classes must aspire — knowing, as he does, that classification by type is simply an acknowledgment of ignorance and a temporary device." Educational Value of Natural History Sciences; Lay Sermons, Addresses and Reviews, pp. 82, 83.

class of work will be least harsh in their criticism of its defects.

The key is based almost entirely on the generic descriptions, and is designed not only to aid in the identification of genera, but also, in a general way, to group together those genera which have common characteristics, and thus to aid in a comparison of the different groups. Its usefulness must be lessened by the fact that the generic position of a species has been commonly determined merely by its possessing a greater number of the characteristics of one genus than of any other. For example: Cyrba Simon has legs 4, 1, 3, 2. The greater number of characteristics of C. bi-maculatu Keyserling carry that species to the genus Cyrba, although it has the leg-formula 4, 3, 1, 2. If in the key Cyrba has been distinguished from other genera by the fact that its leg-formula is 4, 1, 3, 2, bi-maculata must go elsewhere.

We have also, for the purpose of facilitating comparison, arranged the characteristics of the different genera in the form of a table.

We have been perplexed by a lack of precision in the stating of characteristics. We venture to suggest that it would be well to express the dimensions of parts in terms of other parts of the same species. For example, the clypeus should be described not as "very low," or "rather high," but as one fifth or one half as wide as the middle anterior eyes. We believe that Menge is the only author who states definitely the height of the cephalothorax. He does so by comparing the height with the width.

Not having the work in which it is described, we have omitted the genus Portia Karsch. In his Arachnol. Blätter V. Zur Attiden-Gattung Portia, Dr. Karsch says that this genus resembles Eris (C. Koch) Simon, but differs from it in that the first pair of legs is not much more robust than the others; metatarsus + tarsus of the fourth are longer than patella + tibia of fourth, not equal or shorter as in Eris); and the spines on the tibiae and metatarsi of the hind legs extend to the base. The quadrangle of the eyes, also, is not wider behind than in front.

As we have undertaken to prepare a monograph of this

family, we shall be very glad to receive Attidae from any part of the world, and to send in return spiders of the United States.

We give below a brief account of the Attid genera.

Milwaukee, Wisconsin, March, 1884.

THE ATTID GENERA.

From Latreille to Walckener, inclusively, the whole family constitutes but one genus, Salticus Latr. or Attus Walck. In 1832 Hentz detached the genera Lyssomanes, Synemosyna, and Epiblemum; Lyssomanes having the eyes in four rows; Synemosyna corresponding in part to Salticus (Latr.) C. Koch, or Leptorchestes Thorell, 1870; and Epiblemum in part to Calliethera C. Koch, 1837. In 1833 Sundevall divided Attus Walck. into two genera, Salticus and Attus. Salticus having the cephalic abruptly higher than the thoracic part, and the quadrangle of the eyes nearly square. Between 1833 and 1850 twenty-four genera were formed by C. Koch, most of which were so poorly defined by their author that their identification has been difficult or impossible. These genera, however, have been used as a basis of work by later authors who have redefined and united them, so that eighteen out of Koch's twenty-four genera are still used, beside some of his sub-genera which have been raised to the rank of genera by Thorell. A short history of C. Koch's genera would run as follows: Heliophanus, 1833; Euophrys, 1834; Dendryphantes, 1837; Pyrophorus, 1837; (the name Pyrophorus had already been used, and the genus was identical with Salticus (Latr.) Sund., 1833); Toxeus, 1846; (probably also included in Salticus (Latr.) Sund.; Janus, 1846; (the name Janus was preoccupied; the genus is in part Synemosyna Hentz, 1832, and in part Janigena Karsch, 1880); Philia, 1846, (the name Philia was preoccupied, and for it Thorell substituted, Philæus in 1870); Hyllus, 1846; (identical with Dineresus White, formed in the same year); Thiania, 1846; Marpissa, 1846; (the name Marpissa was preoccupied;

Thorell substituted Marptusa in 1877); Cocalus, 1846; Plexippus, 1846; Phidippus, 1846; Amycus, 1846; Alcmena, 1846; Asaracus, 1846; (this genus, without any striking characteristic, and formed for one imperfect individual, has never been used); Phyale, 1846; Eris, 1846; Ciris, 1848; Mævia, 1848; Rhanis, 1848 (identical with Homalattus White, 1841); Psecas, 1850; (this vaguely characterized genus has not been adopted by later authors); Icelus, 1850; (the name Icelus being preoccupied Simon substituted Icius in 1873); Ballus, 1850; (this was a sub-genus of Attus, made a genus by Thorell in 1870); Dia and Parthenia, two sub-genera of the genus Euophrys, were combined and made a genus with the name Ælurops (both Dia and Parthenia being preoccupied) by Thorell also in 1870.

During this period only one author, beside Koch, made any genera in the family Attidae. This was A. White, who, in 1841, made Homalattus; and in 1846 Dineresus, of which Hyllus C. Koch, takes precedence; and after 1850 no new genera were formed for many years. Of Westring and Blackwall, both writing in 1861, the former followed Sundevall's division (1833), into Salticus and Attus, while the latter used only Salticus Latr. unmodified. In 1864, Simon combined the Attid genera to form five: Rhanis C. Koch, Attus Walck, Cyrtonota Sim., Heliophanus C. Koch, and Salticus (Latr.) This arrangement, which was not generally adopted, seems not to have satisfied its author, as in 1869, Simon made an entirely new classification of the Attidae, recombining them into ten genera of which two, Menemerus and Yllenus were new.

We now come to 1870, in which year Thorell published the first part of his work on the genera and species of European spiders, probably the most important contribution thus far offered to arachnological literature in the department of classification. In so far as the Attidae are concerned his most valuable work was the unravelling of C. Koch's European genera. He resolved the family into thirteen provisional genera, one of which, Leptorchestes, was new. He also formed the genus Diolenius for the species A. phrynoides Walck.; and he made the changes in the

nomenclature of some of C. Koch's genera which have already been mentioned.

In 1871, the genus Hasarius was formed by Simon. In 1872, Taczanowski described a new genus, Jelskia, which he placed under the family Dinopidae, but which seems to us to belong to the Attidae, since although the eyes are in four rows, (as in Lyssomanes Hentz), the eyes of the third row, are small, not as in the Dinopidae, larger than the others. In 1873 Simon substituted the name Icius for Icelus C. Koch.

In 1876, Simon modified his classification of the Attid genera, and succeeded in making an arrangement so good that as Dr. L. Koch remarks, it will form the basis for all future work. The new genera which he formed in this year were Synagles, Neera, Neon, Hyctia, Thya, Saitis, Pellenes, Habrocestum, Cyrba and Phlegra.

In 1877, Thorell made the genera Agorius and Viciria, and substituted the name Marptusa for Marpissa C. Koch. In the same year Simon formed the genus Bavia, and Simon and Cambridge each described a genus having the eyes in four rows; these are Evenus Simon, and Athamas Cambridge. Also in 1877, the genera Oedipus and Scartes were formed by Menge.

In 1878, Thorell formed the genera Boethus and Sinis; Karsch, the genera Lycidas, Ligonipes, Ligurinus, Maratus, Ascyltus and Mopsus; and Taczanowski, the genus Chirothecia.

In 1879, L. Koch formed the genera Astia, Scirtetes, Rhombonotus, Scaea, and Lagnus, and in 1880, Opisthoncus. In 1880, also, we have the genus Janigena Karsch. In 1881, Keyserling formed Jotus, and Ergane, and Thorell, Simaetha, Discocnemius, Ephippus, Euryattus, Omoedus and Coccorchestes.

In 1882, Keyserling formed Thorellia (which afterwards proved to be identical with Saitis Simon), Eulabes, Tanypus, Acmaea (these three names being preoccupied they were afterward supplanted, Eulabes by Pirithous, Tanypus by Sinnamora, and Acmaea by Drepanephora); Morgaromma, Erasmia, Sobara, Selaophora, Prostheclina, Cytaea, Atry-

tone, Hadrosoma and Therosa; and Cambridge formed the genus Mago. This latter author, who has described a large number of species, has, with a few exceptions, included them all in the genus Salticus Latr.

In 1883, Keyserling formed the genera Lauharulla, Scythropa and Sandalodes, and substituted the names Pirithous, Sinnamora, and Drepanephora for Eulabes, Tanypus, and Acmaea.

In 1884 Simon formed the genera Mithion, Lystrocteisa and Chalcolecta.

Finding that several generic names now in use are preoccupied we make the following substitutions:

For Evenus Simon 1877, "Epeus." (Evenus Hübu. Lep. 1816. Agassiz' Nomencl. Zool. Evenus Lap. Col. 1836. Agassiz' Nomencl. Zool.)

For Sinis Thorell 1878, "Linus." (Sinis Heer. Col. 1862. Scudder's Nomencl. Zool.)

For Scirtetes L. K. 1879, "Damoetas." (Scirtetes Wagn. Mamm. 1841. Agassiz' Nomencl. Zool.)

For Ephippus Thorell 1881, "Zenodorus." (Ephippus Cuv. Pisc. 1829. Agassiz' Nomencl. Zool.)

For Erasmia Keyserling 1882, "Iona." (Erasmia Hope. Lep. 1840, Agassiz' Nomencl, Zool. Erasmia Heine. Aves 1863. Scudder's Nomencl. Zool.)

For Atrytone Keyserling 1882, "Tara." (Atrytone Scud. Lep. 1872. Zool. Record.)

For Hadrosoma Keyserling 1882, "Bootes." (Hadrosoma Fieb. Orth. 1853. Scudder's Nomencl. Zool.)

For Scythropa Keyserling 1883, "Bianor." (Scythropa Chand. Col. 1871. Zool. Record.)

For Drepanephora Keyserling 1883, "Hypoblemum." (Drepanephora Loew. Dipt. 1869. Zool. Record.)

We divide the family Attidae into two sub-families, the Attinae, having the eyes in three rows, and the Lysomanae, having the eyes in four rows.

KEY TO THE GENERA OF THE FAMILY ATTIDAE.[1]

1. Eyes in three rows 3
2. Eyes in four rows 161
3. [2]Trochanter I elongated much longer than the others 5
4. Trochanter I not elongated 13
5. Trochanter I much longer than coxa, shorter than femur 7
6. Trochanter I shorter than coxa (especially ♀), much shorter than femur 9
7. Cephalothorax low; quadrangle of eyes wider than long; tibia I slender and parallel ..... [3]**Tara Peckham.**
8. Cephalothorax rather high; quadrangle of eyes almost equal in length and breadth; tibia I more or less dilated.... **Diolenius Thor.**
9. Quadrangle of eyes much longer than wide, and much longer than thoracic part; eyes of second row much nearer lateral than dorsal eyes ..... **Lystrocteisa E. S.**
10. Quadrangle of eyes almost equal in length and breadth; thoracic and cephalic parts almost equally long; eyes of second row scarcely further from dorsal than from lateral 11
11. Legs short; anterior tibia strongly compressed and dilated, and conspicuously furnished below with two rows of strong spines, and in the middle line with thick hairs..... **Discocnemius Thor.**
12. Legs long; anterior tibia compressed, parallel, not dilated; armed below with numerous and strong spines in a double row. **Chalcolecta E. S.**
13. Cephalothorax distinctly wider in the middle than at the ends. **Rhombonotus, L. K.**
14. Cephalothorax not distinctly wider in the middle than at the ends 15
15. Body slender, antlike; legs weak 17
16. Body not antlike in form 29
17. Cephalic part higher than thoracic..... **Salticus Latr.**
18. Cephalic part not higher than thoracic 19
19. Abdomen with a distinct constriction 21
20. Abdomen without, or with a very slight constriction 23
21. Cephalic and thoracic parts separated by a constriction. **Janigena Karsch.**

[1] On account of the vagueness of their definitions, we have been obliged to omit from the Key the genera Phyale, Asaracus, Alcmena, Psecas, and Thiania of C. Koch, and Lycidas, Ligurinus, and Maratus Karsch.

[2] We have here made use of the table given by M. Simon in his *Note sur le Groupe des Diolenii.* This group, so far as is yet known, is confined to Australian and Malesian islands.

[3] **Tara** = Atrytone Keyserling, preoccupied.

22. A constriction dividing the thoracic part into a shorter anterior and a longer posterior portion.....**Synemosyna Hentz.**
23. Sternum prolonged between coxae I..... 25
24. Sternum not prolonged between coxae I.....**Agorius Thor.**
25. Pedicle of the abdomen not visible from above..[1] **Damoetas Peckham.**
26. Pedicle visible from above..... 27
27. Sternum scarcely as wide as intermediate coxae; labium at least twice as long as wide .....**Leptorchestes Thor.**
28. Sternum wider than intermediate coxae; labium as long as wide. **Synageles F. S.**
29. Clypeus very low in front, high below anterior lateral eyes, extended and a little curved backward on the sides, forming an acute angle below the eyes of the second row....**Ascyltus Karsch.**
30. Sides of clypeus forming no acute angle..... 31
31. Body short, convex, beetle like; cephalic part not, or scarcely so long as thoracic... 33
32. Body not beetle like in form[2]..... 35
33. Body strongly convex both longitudinally and transversely; abdomen high and widely truncated in front, where it is received into an excavation of the cephalothorax; eyes of the second row further from the dorsal than f om the lateral eyes. **Coccorchestes Thor.**
34. Anterior part of abdomen not overlapped by cephalothorax; eyes of second row half way between dorsal and lateral eyes. **Omoedus Thor.**
35. Cephalic part as long as, or longer than thoracic 37
36. Cephalic part shorter than thoracic 61
37. Eyes of the second row at least half as large as eyes of the third row .....**Cocalus C. K.**
38. Eyes of second row less than one half as large as eyes of the third row..... 39
39. Quadrangle of eyes longer than wide; tibia I greatly dilated. **Chirothecia Tacz.**
40. Quadrangle as wide as, or wider than long; tibia I not dilated.... 41
41. Cephalic and thoracic parts equal..... 43
42. Cephalic part longer than thoracic..... 55
43. Legs III and IV without spines.....**Ballus C. K.**
44. Spines on the four pairs..... 45
45. Third leg longer than fourth..... ... 47
46. Third leg shorter than fourth 49

---

[1] Damoetas=Scirtetes L. K., preoccupied.

[2] Some of the species of Homalattus White resemble beetles, but in this genus the cephalic part is longer than the thoracic.

47. Quadrangle of the eyes wider behind: third leg much longer than fourth.....[1]**Neaetha E. S.**
48. Quadrangle of eyes wider in front; third leg but little longer than fourth.....**Ciris C. K.**
49. Cephalothorax not wider than third row of eyes at that place ... 51
50. Cephalothorax wider than third row of eyes at that place; lateral eyes of first row well separated from middle eyes... **Pirithous Keys.**
51. Anterior row of eyes curved; lateral widely separated from middle eyes 53
52. Anterior row of eyes almost straight: lateral but little removed from middle eyes.....[2] **Bianor Peckham.**
53. Quadrangle of eyes equally wide in front and behind: metatarsus + tarsus IV longer than patella + tibia; tibial and metatarsal spines to the base, on legs III and IV..... **Portia Karsch.**
54. Quadrangle of eyes wider behind than in front; metatarsus + tarsus IV, equal to or shorter than patella + tibia; only circles of spines at the extremities of the tibiae and metatarsi of legs III and IV..... **Eris, C. K.**
55. Quadrangle of eyes wider in front than behind.....[3] **Iona Peckham.**
56. Quadrangle of eyes not wider in front 57
57. Cephalothorax as high behind as it is long .....**Mago Cambridge.**
58. Cephalothorax not as high behind as long 59
59. First row of eyes straight, touching.....**Neon E. S.**
60. First row of eyes curved, separated by nearly equal distances from each other.....**Homalattus White.**
61. Quadrangle of eyes longer than wide 63
62. Quadrangle of eyes wider than long..... 65
63. Quadrangle of eyes more than twice as long as wide..
Ligonipes Karsch.
64. Quadrangle of eyes one fourth or one fifth only longer than wide.....[4]**Plexippus C. K.**
65. A more or less prominent tubercle between the dorsal eyes.
Opisthoncus L. K.
66. No tubercle present..... 67
67. Cephalothorax short and very high, thoracic part much dilated and falling steeply from cephalic plate; cephalothorax wider than the third row of eyes.....[5]**Amycus C. K.**
68. Form of cephalothorax unlike the above 69
69. Quadrangle of eyes wider in front than behind..... 71

---

[1] Neaetha=Neaera E. S., preoccupied.

[2] Bianor = Scythropa Keyserling, preoccupied.

[3] Iona = Erasmia Keyserling, preoccupied.

[4] See genus Plexippus.

[5] The face in Amycus is very high, but not equally high in the different species.

70. Quadrangle as wide or wider behind..... 91
71. Tibia + patella III shorter than tibia + patella IV..... 73
72. Tibia + patella III longer than tibia + patella IV..... 81
73. Metatarsus + tarsus IV equal to or shorter than patella + tibia IV. 75
74. Metatarsus + tarsus IV longer than tibia + patella IV..... 77
75. Metatarsus IV spined only at extremity .....**Lauharulla Keys.**
76. Metatarsus IV spined to base..... .....**Astia L. K.**
77. Cephalothorax wider than third row of eyes 79
78. Cephalothorax not wider than third row of eyes....**Sinnamora Keys.**
79. Legs moderately long; metatarsus IV with spines.....**Boethus Thor.**
80. Legs extremely long; metatarsus IV without spines .....**Lagnus L. K.**
81. Eyes of the second row more than $\frac{1}{3}$ as large as dorsal eyes; tibiæ spined above ....[1] **Linus Peckham.**
82. Eyes of second row less than $\frac{1}{3}$ as large as dorsal eyes; tibiæ not not spined above 83
83. Cephalothorax not wider than third row of eyes 85
84. Cephalothorax wider than third row of eyes 87
85. Cephalothorax narrow in front, wider and rounded behind; quadrangle of eyes scarcely wider than long .....**Prostheclina Keys.**
86. Cephalothorax with sides nearly parallel; quadrangle of eyes one-third wider than long .....**Saitis E. S.**
87. Abdomen very long and slender, much longer than cephalothorax; cephalothorax much wider than third row of eyes ...**Vieiria Thor.**
88. Abdomen rather short; cephalothorax but little wider than third row of eyes 89
89. Abdomen about as wide as long; eyes of second row further from lateral than from dorsal eyes .....**Margaromma Keys.**
90. Abdomen slender; eyes of second row half way between lateral and dorsal eyes.....**Therosa Keys.**
91. Quadrangle of eyes equally wide in front and behind; tibia + patella III longer than tibia + patella IV..... 93
92. Quadrangle of eyes wider behind; or equally wide in front and behind, with tibia + patella III equal to, or shorter than tibia + patella IV..... 99
93. Eyes of the third row distant by at least double their diameter from the margin of the cephalothorax .....[2] **Zenodorus Peckham.**
94. Eyes of the third row not, or only a little removed from the margin of the cephalothorax 95
95. Metatarsus + tarsus IV equal to, or shorter than, tibia + patella IV..... 97
96. Metatarsus + tarsus IV longer than tibia + patella IV.
Ergane Keys.

---

[1] Linus = Sinis Thorell, preoccupied.

[2] Zenodorus=Ephippus Thorell, preoccupied.

Legs III and IV nearly equal; eyes of third row further from each other than from lateral borders; anterior lateral well separated from large middle eyes.....**Cytaea Keys.**

Third legs longer than fourth; eyes of third row equally far from each other and from lateral borders; anterior lateral very near large middle eyes.....**Habrocestum E. S.**

Quadrangle of eyes equally wide in front and behind; anterior row of eyes straight..... 101

. Quadrangle wider behind; or, if equally wide in front and behind, anterior row curved..... 117

. Coxae I touching.. .....**Hyctia E. S.**

. Coxae I separated by width of labium..... 108

. Tibia IV as large as patella at base, cylindrical, parallel or a little enlarged at extremity..... 105

. Tibia IV narrower than patella at base; slightly enlarged and a little compressed at extremity..... 109

. Quadrangle of eyes as long as wide; fore central eyes excessively large, at least five times as large as the lateral.....**Mithion E. S.**

. Quadrangle of eyes wider than long; fore central eyes not excessively large..... 107

. Thoracic part a little dilated; coxæ IV longest.....**Menemerus E. S.**

. Thoracic part parallel; coxæ I largest.....**Bavia E. S.**

. Patella III as long as or longer than patella IV; tibia III much shorter than tibia IV, but more robust..... 111

. Patella III shorter than Patella IV; tibia III more slender than tibia IV..... 113

. Clypeus at least ½ as wide as large middle eyes; patellae always without spines..... .....**Euophrys C. K.**

. Clypeus very narrow, scarcely ¼ as wide as large middle eyes; patellae armed with two spines ....**Cyrba E. S.**

. Sternum wider than intermediate coxae; (♂) femur of palpus armed with a strong apophysis..... **Heliophanus C. K.**

. Sternum of same width or narrower than intermediate coxae; femur of palpus unarmed..... 115

. Thoracic part twice as long as cephalic.....**Phlegra, E. S.**

. Thoracic part only ½ longer than cephalic.....**Attus Walck**

. Quadrangle of eyes equally wide in front and behind..... 119

. Quadrangle of eyes wider behind..... 133

. Anterior row of eyes strongly curved, a straight line from the summit of the middle eyes cutting the lateral eyes through, or below the middle.....**Scaea C. K.**

. Anterior row of eyes slightly curved, a straight line from summit of middle eyes cutting lateral eyes above the middle..... 121

. Legs without femoral and tibial spines; (♂) falces long and horizontal.....**Epiblemum Hentz**

122. Legs having femoral and tibial spines on the four pairs..... 123
123. Eyes of the third row nearer to each other than to lateral borders.....**Maevia E. S.**
124. Eyes of the third row equally distant from lateral borders and from each other..... 125
125. Eyes of the second row nearer the dorsal than the lateral eyes, **Selaophora Keys.**
126. Eyes of second row half-way between dorsal and lateral eyes, or nearer the lateral..... 127
127. Cephalothorax only ⅛ larger than wide; scarcely wider than third row of eyes; first legs not stouter than the others, [1] **Bootes Peckham.**
128. Cephalothorax at least ⅕ longer than wide; first legs stouter than the others..... 129
129. Cephalothorax considerably wider than third row of eyes; moderately high..... 131
130. Cephalothorax only slightly wider than third row of eyes; very high and convex.....**Jotus Keys.**
131. Second row of eyes half-way between dorsal and lateral eyes; falces not diverging.....**Sandalodes Keys.**
132. Second row of eyes nearer the lateral than the dorsal eyes; falces diverging.....**Hyllus C. K.**
133. Anterior row of eyes very strongly curved, a straight line from the summit of the middle eyes cutting only the lower borders of the lateral eyes.....[2] **Elurillus E. S.**
134. Anterior row of eyes straight or only moderately curved, a straight line from the summit of the middle eyes cutting the lateral eyes not below the middle..... 135
135. Clypeus as wide as large middle eyes..... 137
136. Clypeus not so wide as large middle eyes..... 139
137. Cephalothorax as wide as or barely narrower than long. **Sobara Keys.**
138. Cephalothorax at least ½ longer than wide.....**Mopsus Karsch.**
139. Tibia + patella III shorter than tibia + patella IV 141
140. Tibia + patella III as long as or longer than tibia + patella IV .. 153
141. Coxae I separated by width of labium at base..... 145
142. Coxae I touching or nearly touching..... 143
143. Cephalothorax short, high, convex; relative length of legs 1, 4, 2, 3; abdomen short.....**Simaetha Thor.**
144. Cephalothorax elongated, flattened; relative length of legs 1, 2, 3, 4; abdomen long .....**Marptusa Thor.**
145. Trochanter IV very long, diverging, visible from above; tarus and metatarus IV as thick as tibia and patella .....**Yllenus E. S.**

---

[1] Bootes=Hadrosoma Keyserling, preoccupied.

[2] Elurillus=Aelurops Thorell, preoccupied.

. Trochanter IV short, not visible from above; metatarsus and tarsus IV more slender than tibia and patella 147
, Metatarsus IV having only a circle of spines at extremity (sometimes lacking these)..... 149
. Metatarsus IV armed to base 151
. Anterior row of eyes rather strongly curved; legs very hairy, **Dendryphantes C. K.**
. Anterior row of legs straight or almost straight: legs almost glabrous..... ....**Icius E. S.**
. Eyes of second row double as far from dorsal as from lateral eyes..... **Phidippus C. K.**
. Eyes of second row almost half-way between dorsal and lateral eyes.....**Philaeus Thor.**
. Interval between lateral and middle eyes of first row as wide or nearly as wide as the diameter of the lateral..... 155
. Lateral separated by a space not more than ½ as wide as their diameter from the middle eyes..... 157
. Cephalothorax dilated toward the front; clypeus very low, less than ¼ as wide as the laree middle eyes .....**Euryattus Thor.**
. Cephalothorax with thoracic part very strongly dilated; clypeus about ½ as wide as large middle eyes.....[1]**Thyene E. S.**
. Metatarsus + tarsus IV equal to tibia + patella IV 159
. Metatarsus + tarsus IV shorter than tibia + patella IV. **Pellenes E. S.**
. Second legs longer than the first .....[2]**Hypoblemum Peckham.**
. First legs longer than the second.....**Hasarius E. S.**
. Cephalic and thoracic parts on the same plane..... 163
. Cephalic and thoracic parts on different planes.....**Jelskia Tacz.**
. Thoracic part but little longer than cephalic 165
. Thoracic part much longer than cephalic.....**Lyssomanes Hentz.**
. First pair of legs longest; cephalic part very convex, sides parallel .....**Athamas Cambridge.**
. Third pair of legs longest; cephalic part plane, sides converging behind .....[3]**Epeus Peckham.**

Thyene=Thya Simon, preoccupied.
Hypoblemum=Drepanephora Keyserling, preoccupied.
Epeus=Evenus Simon, preoccupied.

SUB-FAMILY ATTINÆ.

DIOLENIUS THORELL, 1870.

Syn.: 1870. **Diolenius** THORELL, on Europ. Spid. Part I, p. 208.
1878. " ID., Ragni Malesi e Papuani, Part II, p. 215.
1881. " L. KOCH, Arachniden Australiens, p. 1240.

Thorell (in Europ. Spid., Part I, p. 208,) says that this genus is characterized by the long trochanters of the fore legs.

*TARA N.

Syn.: 1882. **Atrytone** KEYSERLING, Arachniden Australiens, p. 1378.

Cephalothorax low; one quarter longer than wide, in front moderately contracted, behind rounded, wider at the third row of eyes, plane above.

Clypeus very low.

Quadrangle of eyes wider than long, as wide before as behind, placed in front of the middle of the cephalothorax. Dorsal eyes further from each other than from the margin of the cephalothorax. Anterior row of eyes moderately recurved, eyes close together; small medium eyes further from the dorsal eyes than from the lateral anterior eyes.

Falces wide, short, not diverging.

Maxillae dilated in front.

Sternum plane, longer than wide.

Abdomen elongated, above level.

Legs 1, 4, 2, 3, Coxa and trochanter of first pair very much elongated. Patella and tibia of the third shorter than patella and tibia of the fourth; Metatarsus and tarsus of the fourth shorter than the patella and tibia.

LYSTROCTEISA SIMON, 1884.

Lystrocteisa E SIMON. Note sur le Groupe des Diolenii; Comptes Rendus de la Société Entomologique de Belgique. 1884.

Related to Diolenius, but distinct by the following characteristics: ocular quadrangle longer than the thoracic part, much longer than wide, convex in front, flattened in the middle; eyes of the third row very prominent, larger and plainly further apart than the lateral anterior; eyes of the second row much nearer the lateral anterior; trochanter I cylindrical, a little

*Tara is substituted for *Atrytone*, the latter name being preoccupied.

›rter than the coxa, much shorter than the femur; femur very wide, ›viform; tibia almost globular, compressed below with two rows of long ›ss; metatarsus slender, with two pairs of long spines.

CHALCOLECTA SIMON. 1884.

›alcolecta E SIMON. Note sur le Groupe des Diolenii; Comptes Rendus de la Société Entomologique de Belgique. 1884.

Ocular quadrangle at least as long as the thoracic part, of the same form that of Diolenius; anterior row of eyes less curved than in that genus. ›ochanter I shorter than the coxa (particularly ♀) and much shorter than e femur; femur and tibia I very long, compressed, parallel, not dilated, ›d tibia provided below with two rows of at least 10 + 10 strong spines, ternately shorter and longer; metatarsus shorter than the tibia, ♂ shorned, compressed and angular[1], ♀ cylindrical and provided below with ree or four pairs of long spines; relative length of legs 1, 4, 3, 2.

DISCOCNEMIUS THORELL. 1881.

›iscocnemius THORELL, Studi sui Ragni Malesi e Papuani, III, p. 428.

›phalothorax long, moderately high, cephalic part not abruptly higher than thoracic, limited by a transverse depression.

›ypeus very low.

›ernum not narrower than the coxae, not usually projecting between those of the first pair.

›es area occupying about half the length of the cephalothorax; quadrangle at least as wide behind as it is long; anterior middle eyes very large; eyes of the second row almost in the middle, between the posterior and the anterior lateral eyes; posterior eyes scarcely or not higher by their own diameter than the anterior lateral eyes.

›axillae sub-parallel, about twice as long as wide, and about twice as long as the lip. Lip longer than wide, sub-truncated at the extremity.

›gs 4, 1, 2, 3, slender, except the first pair, which is robust (excepting the metatarsus and tarsus); tibia especially wide and compressed, and underneath furnished with a medium longitudinal fascia of dense, long hairs, and two rows of spines, patella and trochanter not usually longer.

›domen long.

›innerets six, superior and inferior not differing much in length, last joint short.

›pe: D. lacertosus.

Related both to Diolenius Thorell and Chirothecia Tacz.

---

[1] In the original this sentence reads "metatarse plus court que le tibia, mutique comprimé et auguleux," etc.

SALTICUS (LATR.) 1804. SIMON.

Syn.: 1804. **Salticus** LATR., Nouv. Dict. d'Hist. Nat., XXIV, p. 135, (ad partem).
1805. **Attus** WALCK., Tabl. d. Aran., p. 22 (ad partem).
1837. **Pyrophorus** C. KOCH, Uebers. d. Arachn.—Syst., 1, p. 29.
1846. **Toxeus** C. KOCH, Die Arachn., XIII, p. 19.
1864. **Salticus** [SALTICA]: Sub-gen. Pyrophorus [Pyrophora] Sim. H. N. D. Araignees, p. 336.
1869. **Pyroderes** ID., Monogr. d. Attid., p. 248 (714).
1870. **Salticus** THORELL, On Europ. Spid. I, p. 208.
1871. " SIM., Révis. d. Attid.
1876. " ID., Arachn. de France, III, p. 6.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 213.
1878. " LEBERT, Die Spinnen der Schweiz, p. 296.
1878. " TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 371.
1879. " L. KOCH, Arachniden Australiens, p. 1055.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch, f. d. gesammt. Naturwissensch., LIII p. 395.
1880. **Toxeus** ID., ibid., pp. 393, 394.

Cephalothorax elongated; cephalic part high, parallel, level, almost as wide as long, its posterior angles rounded; thoracic part narrower, lower, on a different plane, rounded or obtusely truncated behind.

Clypeus very narrow, with sparse hair.

Eyes of the face very unequal, sub-touching, in a straight line, with some hairs around them; dorsal eyes as large as the lateral, a little further apart, forming with them a group wider than long, not, or scarcely projecting.

Sternum very narrow, projecting between the anterior coxæ.

Falces (♂) very long, flat above, horizontal; inferior border of the groove with a continuous row of strong teeth. (♀) Falces short, robust, vertical.

Maxillæ long, square at the extremity, with the superior external angle projecting a little.

Lip much longer than wide, almost parallel, truncated or slightly hollowed.

Palpus (♂) slender; tibia as long and wider than the patella; tarsus oval, rather narrow, and truncated; bulb discoidal, occupying only the inferior part of the tarsus. (♀) Palpus with the tibia and tarsus enlarged in the form of an oval palette.

Legs 4, 1, 3, 2: Third and fourth pairs unarmed; tibiæ and metatarsi of the first and second pairs with two rows of inferior spines; tibia of the first much longer than the patella; patella and tibia of the third much shorter than the patella and tibia of the fourth; tarsus and metatarsus of the fourth a little shorter than the patella and tibia.

LEPTORCHESTES (THORELL) 1870. SIMON.

Syn.: 1832. **Synemosyna** HENTZ, On North Amer. Spid., p. 108 (ad partem).
1837. **Salticus** C. KOCH, Uebers. d. Arachn.—Syst., 1, p. 29 (ad partem.)
1869. " SIM. Monogr d. Attid., p. 6 (16), 241 (707) (ad partem).
1870. **Leptorchestes** THORELL, On Europ. Spid., I, p. 209 (ad partem).
1871. " SIM., Révis. d. Attid. (ad partem).
1876. " ID., Arachn. de France, III. p. 10.
1878. " LEBERT, Die Spinnen der Schweiz, p. 297.
1879. " L. KOCH, Arachniden Australiens, p. 1057.

Cephalothorax plane, but little elevated, parallel, rounded or obtusely truncated behind; a slight transverse depression separating the cephalic part.

Clypeus very narrow.

Eyes of the face very unequal, in a straight line, touching. Dorsal eyes of the same size or barely smaller than the lateral, forming with them a group much longer than wide.

Sternum at least as narrow as the intermediate coxæ, projecting between the anterior coxæ.

Lip almost twice as long as wide, parallel, terminating in an obtuse point.

Falces robust, short, vertical in both sexes.

Palpus (♂) not robust; tibia short with an external apophysis; bulb simple.

Legs 4, 1, 3, 2; third and fourth pairs unarmed: (♂) metatarsi of the first and second with some inferior spines; (♀) tibiæ and metatarsi of the first and second presenting two rows of inferior spines; patella and tibia of the third much shorter than patella and tibia of the fourth; metatarsus and tarsus of the fourth shorter than the patella and tibia.

SYNAGELES SIMON. 1876.

Syn.: 1837. **Salticus** C. KOCH, Uebers. d. Arachn.—Syst., I, p. 29 (ad partem).
1869. " SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 241 (707) (ad partem).
1870. **Leptorchestes** THORELL On Europ. Spid. I, p. 209 (ad partem)
1871. " SIM.
1876. **Synageles** ID., Arachn. de France, III, p. 14.
1883. " ID., Arachn. de L'Ocean Atlantique, Ann. Soc. Ent. de France 1862, p. 261.

Cephalothorax flat, but little elevated, very much elongated, parallel, obtusely truncated behind; a slight horizontal depression separating the cephalic part.

Eyes: The dorsal eyes situated a little beyond the middle of the cephalothorax, scarcely projecting above, of the same size as the lateral, and forming with them a group much longer than wide. Eyes of the face very unequal, touching, forming a straight line, surrounded by fine circles of hairs.

Clypeus very narrow; hairs forming the beard sparse.

Sternum oval, more slender at the two extremities, wider in the middle than the intermediate coxae, projecting between the anterior coxae.

Lip at least as wide as long, semi-circular, or in a very obtuse triangle.

Maxillæ extending much beyond the lips but nevertheless rather short and very wide. Square at the extremity.

Legs: Fourth legs the longest; the three anterior pairs equal or almost equal; the two posterior pairs unarmed; (♂) metatarsi of the first and second alone provided with some inferior spines; (♀) tibiae and metatarsi of the first and second presenting two rows of inferior spines; tibia of the first robust, of the same length or scarcely shorter than the patella; patella and tibia of the third much shorter than patella and tibia of the fourth; metatarsus and tarsus of the fourth shorter than patella and tibia.

Falces (♂ ♀) robust, short, vertical.

Palpus (♂) not very robust; tibia very short, provided with an external apophysis; tarsus obtuse oval; bulb simple, reaching at least the superior third of the tarsus; (♀) rather slender; tarsus slightly enlarged and cylindrical.

AGORIUS THORELL. 1877.

Agorius THORELL, Studi sui Ragni Malesi e Papuani, I, p. 216.

Cephalothorax about twice as long as wide, the posterior part plainly narrowing a little, almost vertical towards the sides, rather low, the cephalic part scarcely higher than the thoracic.

Clypeus very low, less than ¼ the diameter of the anterior middle eyes, without thick hairs.

Sternum much wider than the coxæ, not projecting between the coxæ of the first pair.

Eyes: Are a large, occupying almost half the length of the cephalothorax. Quadrangle only a little wider than long, at least as wide in front as behind. Anterior row of eyes rather strongly curved upward, middle eyes plainly visible when the cephalothorax is looked at from above, touching, the lateral well separated from the middle, eyes of the second row small, and a little further from the posterior eyes,

which are but little smaller than the anterior lateral eyes, than from these; posterior eyes further from each other than from the margin of the cephalothorax.

Falces small, vertical (at least in ♀).

Maxillae diverging a little, sub-ovaté, the extremities appearing rounded, almost twice as long as the lip, which is a little wider than long, narrowing toward the apex.

Legs exceedingly slender, long: 4, 1, 3, 2; trochanters, at least of the fourth pair, much longer than thick; space between the coxæ of the first pair nearly as wide as the sternum; posterior tibiæ and metatarsi without spines. First pair with patellae very long, almost as long as the femora, and the tibiæ and metatarsi, on the contrary, very short. Two claws, small, slender, bent, strongly curved at the apex, armed with teeth, especially small and short in the tarsi of the first pair; claw tufts distinct.

Abdomen slender, sub-cylindrical; pedicle short, not articulated.

Maxillae longer, sub-cylindrical.

Pubescence fine and sparse.

Type. A. gracilipes.

This genus is related to Synemosyna Hentz, Salticus Latr., Leptorchestes Thor., and especially to Synagels Sim., differing from this genus in not having the sternum produced between the coxae of the first pair, in the quadrangle of the eyes being shorter, and in the structure of the first pair of legs, which resemble those of Diolenius Thor. However, in Diolenius, it is the trochanters which are elongated, not, as in Agorius, the patellae.

[1] DAMŒTAS N.

Syn.: 1879. Scirtetes L. Koch, Arachn. Australiens, p. 1070.

Cephalothorax almost twice as long as wide, slightly rounded on the sides contracted equally toward the anterior and posterior, convex above. Clypeus low, equaling in height the radius of the lateral eye of the first row.

Quadrangle of eyes longer than wide, wider behind than in front; third series of eyes as wide as cephalothorax. First row of eyes slightly recurved, placed close together. Eyes of the third row more widely separated from each other than they are separated from the margin of the cephalothorax. The middle eyes are much further from the posterior eyes than they are from the lateral eyes of the first row.

Maxillae convex, margin in front a little rounded. *Lip* scarcely equals half the length of the maxilla, convex, contracted toward the anterior, the tip rounded and swollen.

Sternum long and contracted, convex, projecting between the first pair of thighs.

---

[1] *Damœtas* is substituted for *Scirtetes*, the latter name being preoccupied.

Abdomen twice as long as wide; anterior part limited by a transverse impression, covered by a thin skin; posterior part convex, clothed with a hard dorsal integument.

Legs spined, 1, 4, 2, 3; 1 and 4 equal, and 3 and 4 differ slightly in length; first pair stouter than the others. Patella with the tibia of the third pair shorter than the same articulations of the fourth pair; the metatarsus and the tarsus of the fourth pair are shorter than the patella with the tibia.

JANIGENA KARSCH. 1880.

Syn.: 1846. **Janus** C. KOCH. Die Arachn., XIII, p. 21. (ad partem).
1880. **Janigena** KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitschr, f. d. gesammt. Naturwissensch., LIII p. 393.

The cephalic part sharply marked off, but not higher than the thoracic part, very flat and wide. The quadrangle of the eyes is wider behind than in front, the palpus over-reaches the very short mandible, also in the male in length in wide contrast to Toxeus and Synemosyna. The two single barren typical specimens do not admit of a more exact definition. Type, Janus melanocephalus (K). As the generic name Janus was preoccupied, (Verany, 1844, Gastropoda) Karsch proposed the name Janigena.

Thorell, in his review of the genera of European spiders, p. 36, had called attention to the fact that the name Janus was preoccupied, even before Verany, 1844. (Janus Steph. [Hymenopt] 1835). See remarks on the genus Synemosyna under that genus.

SYNEMOSYNA HENTZ. 1832.

Syn.: 1832. **Synemosyna** HENTZ, on North Amer. Spid., p. 108.
1846. **Janus** KOCH, Die Arachn., XII I, p. 21 (ad partem).
1870. **Leptorchestes** THORELL, on Europ. Spid., I. p. 209 (ad partem).
1876. " SIM., Arachn. de France, III, p. 10 (ad partem.)
1877. **Synemosyna** THORELL, Studi Ragni Malesi e Papuani, I, p. 198.
1878. **Janus** TACZ., Araneides du Pérou, Bull. Soc. Imp. des Nat. de Moscou. L. III, 4, p. 372.
1879. **Synemosyna** L. KOCH, Arachniden Australiens, p. 1052.
1880. **Synemosyna** KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitschr. f. d. gesammt. Naturwissensch., L. III, p. 395.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 406.

Eyes eight, unequal, in three rows, the first composed of four eyes, the two middle ones largest, the second composed of two small ones placed nearer the first than the third, which is composed of two larger eyes.

Falces short in the females.

Maxillae slightly inclined toward the lip, truncated at the tip.

Lip short, rounded.

Legs slender, fourth pair longest, the other three variable.

Abdomen contracted near the middle: body nodose, elongated.

Type, S. formica Hentz.

S. formica, upon which species Hentz founded this genus, is undoubtedly identical with Janus gibberosus Koch, which was used to form the genus Janus. Both Hentz and Koch had the spider from Pennsylvania. The other species of Janus described by Koch, J. melanocephalus, has been made the type of the genus Janigena by Karsch.

Hentz, when defining his genus Synemosyna, wrote "cheliceres short in emale," and in contrasting it with Myrmecia notes that in the genus (Myrmecia) "the cheliceres are large in this, (Synemosyna) they are small at least in the female." When describing his typical species — S. formica — he states that "the cheliceres are large *only in the male.*" All the other species placed by him in this genus, both in the male and female have the cheliceres *short.* Now as a matter of fact both sexes in S. formica have short cheliceres. Mr. Emerton first called attention to the error in his notes to Burgess' edition of Hentz's arachnological writings. We have seen a good many males of this spider and all had the short falces. If S. formica represents Hentz's genus, then nearly, if not all, the species placed here by Messrs. L. Koch, Thorell and Karsch, belong in another genus.

RHOMBONOTUS L. KOCH. 1879.

Rhombonotus L. KOCH. Arachniden Australiens, p. 1067.

Cephalothorax almost twice as long as wide, contracted equally in front as behind, slightly convex.

Clypeus about the radius of the middle eyes of the first row.

Quadrangle of eyes longer than wide, narrower in front than behind; the third row of eyes placed behind the middle of the cephalothorax and above the lateral declivity of the same, more widely separated from one another than from the margin of the cephalothorax. The first row of eyes slightly recurved and close together. The middle eyes are nearer the lateral eyes of the first row than the eyes of the third row.

Maxillae moderately convex, anterior margin round.

Labium half as long as the maxilla, a little contracted toward the anterior, the tip rounded.

Sternum convex, long, contracted, projecting between the anterior thighs

Legs 4, 1, 2, 3.: the second and third pairs of equal length, the first pair more robust than the others. Patella with the tibia of the third shorter than the patella with the tibia of the fourth. The fourth leg has the metatarsus with the tarsus longer than the patella with the tibia.

Abdomen cylindrical, constricted in front of the middle by a transverse impression.

OMOEDUS THORELL. 1881.

Omoedus THORELL, Studi sui Ragni Malesi e Papuani, III, p. 668.

Cephalothorax high behind, anteriorly a little dilated above, the back therefore wide, slanting in front of the posterior eyes, behind them nearly level, strongly rounded behind, when looked at from above, only slightly convex transversely; the posterior slope almost vertical, and transversely concave.

Clypeus rather high.

Eyes quadrangle much wider than long, not occupying half the length of the cephalothorax; almost rectangular; anterior row usually curved; eyes of the second row half-way between the posterior eyes and the anterior lateral eyes; posterior eyes at least their own diameter higher than the anterior lateral eyes, and further from each other than from the lateral borders.

Sternum wider than the coxae, not projecting between the widely separated coxae of the first pair.

Falces short, sub-vertical.

Maxillae long, narrow at the base, sub-ovate. Lip scarcely or not wider than long, apex somewhat rounded.

Palpi those of the female not dilated nor flattened toward the apex.

Legs **rather short, (♀) 4, 3, 1, 2 (or 2, 1?); tibia with patella of the fourth pair longer than tibia with patella of the third.**

Abdomen **short, a little flattened, the anterior margin truncated, covered with delicate skin.**

Spinnerets **six, the superior much more slender than the inferior.**

Type O. niger.

This genus resembles Coccorchestes Thor., differing from it especially in having the body sub-flattened, not strongly convex. It differs from ordinary Attidae much less than Coccorchestes.

COCCORCHESTES THORELL. 1881.

Coccorchestes THORELL, Studi sui Ragni Malesi e Papuani, III., p. 671.

Cephalothorax **slanting in front of the posterior eyes, very high behind them and nearly level or ascending, the posterior margin of the back widely truncated.**

Clypeus **high, inclined backward.**

Eyes **quadrangle wider than long, scarcely or not occupying half the greatest length of the cephalothorax; anterior row with the eyes sub-touching, only slightly curved upward, eyes of the second row further from the posterior eyes than from the anterior lateral eyes; posterior eyes more than their own diameter higher than anterior lateral eyes.**

rnum wider than the coxae, not projecting between the separated coxae of the first pair.

ces short, sub-vertical.

rlllae short, narrow at the base, wide at the apex, almost ovate triangular. Lip a little longer than wide, rounded at apex.

pi of the female a little dilated and usually convex toward the apex.

s moderately short, 4, 1, 2, 3 (3, 2), femora robust and compressed.

lomen short, almost ovate triangular, high and widely truncated in front, anterior slope convex, and received into the excavation of the cephalothorax, covered with hard shining scales forming a shield.

nnerets six, the superior longer and more slender than the inferior.

'he whole spider is very convex, both longitudinally and transversely en looked at from above strongly resembling a beetle.

HOMALATTUS WHITE. 1841.

L: 1841. **Homalattus** WHITE. Description of new or little known Arachn., *in* Ann. and Mag. of Nat. Hist., VII, p. 476.

1848. **Rhanis** C. KOCH, Die Arachn., XIV, p. 86.

1870. **Rhene** THORELL, on Europ. Spid. I, p. 37.

1877. **Homalattus** ID., Studi sui Ragni Mal. e Pap., I, p. 289.

1878. **Rhene** TACZ., Aranéides du Pérou, Bull. de la Soc. Imp. de Moscow, LIII, 4, p. 289.

1879. **Homalattus** L. KOCH. Arachniden Australiens, p. 1083.

1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. gesammt. Naturwissensch., LIII, p. 396.

phalothorax flat, transverse, not so wide as the body, covered like it with papillae.

es eight, on short elevations of thorax; may be considered as placed in three lines, two of which are approximate, the third being distant; the first line, which is somewhat bent, contains four eyes, placed on the front margin of the cephalothorax at nearly equal distances from each other, the two intermediate eyes are much the largest. The second line contains two very minute eyes, somewhat removed from the edge of the thorax; they are placed rather nearer the outer eye of the first line than the outer is to the intermediate; the third line contains two eyes, one on each side of the margin of the thorax, the space between the outer eye and the first line being equal to the distance between the outer eyes of the first line.

domen as broad as long; in front straightish; behind somewhat pointed; the sides rounded; it is flat and compressed, and somewhat convex above.

NEON SIMON. 1876.

Syn.: 1869. **Attus** SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 14 (24) (ad partem).

1871. " ID., Revis d. Attid.

1872. **Euophrys** THORELL, on European Spiders, II, p. 404.

1876. **Neon** SIM., Arachn. de France, III, p. 208.

1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwissensch., LIII, p. 397.

Cephalothorax not high; cephalic part a little longer than the thoracic: the latter very slightly contracted and widely truncated.

Eyes of the face touching, forming a straight line. Dorsal eyes at least as large (often larger) than the lateral, very convex, not prominent; as far apart as the lateral eyes, since the sides of the quadrangle are parallel.

Clypeus less than half as wide as the middle eyes, almost glabrous.

Sternum triangular, much wider than the intermediate thighs.

Legs short; those of the fourth pair the longest; those of the first and third pairs nearly equal; those of the second pair the shortest; first pair a little thicker than the others; third and fourth pairs without spines; first and second pairs presenting below two rows of tibial and metatarsal spines usually long and bristle-like. Tibia and patella of the third shorter than tibia and patella of the fourth; tarsus and metatarsus of the fourth very slightly shorter than the patella and tibia.

Falces obliquely inclined, short, slender, taken together narrower than the two middle eyes.

Integument ornamented.

Spinnerets the superior ones longer than the inferior, and more slender; very far apart, leaving visible the inferior ones to the base, formed of two articulations, the second very short.

*IONA N.

Syn.: 1882. **Erasmia** KEYSERLING, Arachniden Australiens, p. 1350.

Cephalothorax one third longer than wide, a little contracted toward the front, behind rounded, not wider at the dorsal eyes, above plain.

Clypeus half the diameter of the large eyes.

Quadrangle of eyes wider than long; wider in front than behind; dorsal eyes placed a little behind the middle of the cephalothorax, almost further from each other than from the margin of the cephalothorax. First row of eyes slightly recurved and very close together. Small median eyes half way between the anterior lateral and the dorsal eyes.

**Iona* is substitued for *Erasmia*, the latter name being preoccupied.

ces short, not diverging.

nium half as long as the maxilla; slightly contracted anteriorly.

rnum oval; one third longer than wide.

s 1, 4, 3, 2. Third and fourth equally long. First pair as stout or a little stouter than than the others. Patella and tibia of the third longer than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth longer than the patella and the tibia. Metatarsus of the fourth without spines.

lomen long, ovate.

MAGO CAMBBIDGE. 1882.

go O. P. CAMBRIDGE. Proc. Zool, Soc., London, May 16, 1882, p. 432.

halothorax as high behind as it is long; the posterior slope curved inwards, but almost perpendicular; profile of upper side of caput slightly convex, and sloping a little forward. The caput is exceedingly large, absorbing, in fact, almost the whole cephalothorax. Looked at from above, its upper surface forms nearly a square; the sides are perpendicular.

ight of clypeus less than the diameter of the fore central eyes.

ular area slightly broader than long, and equal in breadth before and behind; fore central pair of eyes very large, and of a dull, pearl-grey hue; fore laterals in a line with base of fore centrals, and of same color; posterior pair a little smaller than fore laterals, and as nearly as possible equally divided from them by the minute, intermediate eye, which is placed a little inside of their straight line.

ps moderately long, tolerably strong, 1, 3, 2, 4; first pair much the strongest. Armed with spines, and with a small claw-tuft beneath the terminal tarsal claws.

lces long, straight, divergent, and directed forward; denticulations small; fang of moderate length and strength.

xillae long, strong, straight; widened on both sides at the extremities, which are rounded.

bium long, about two thirds the length of the maxillae, and narrower at the apex than base; apex rounded. The direction of the maxillae and labium is very nearly perpendicular (or at right angles) to the *sternum*, which is small, nearly round, slightly pointed behind and truncated in front; the truncation is very gently curved, the convexity of the curve directed backwards.

domen small, short, oval, very convex before, and fitting up pretty closely to the incurved thorax.

ERIS (C. KOCH). 1846. SIMON.

Syn.: 1846. Eris C. KOCH, Die Arachn., XIII, p. 189.
1850. " ID., Uebers. d. Arachn.-Syst., 5, p. 59.
1869. Attus SIM., Monogr. d. Attid., p. 6 (16) 14 (24) (ad partem).
1871. " ID., Révis. d. Attid. (ad partem).
1876. Eris ID., Arachn. de France, III, p. 197.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. gesammt. Naturwissensch., LIII, p. 397.
1883. " SIM., Arachn. de l'Ocean Atlantique. Ann. Soc. Ent. de France, 1882, p. 303.

Cephalothorax moderately high, wide, and short; cephalic and thoracic parts of the same length; the latter very much inclined, contracted, truncated or slightly hollowed.

Clypeus moderately high, with hairs.

Eyes of the face very unequal, in a curved line; the lateral widely separated. Dorsal eyes scarcely smaller than the lateral, situated at the widest point of the cephalothorax, and not prominent.

Sternum short, as narrow or narrower than the intermediate coxae. Interval between the anterior coxae often less wide than the lip at the base.

Falces vertical, short, thick.

Legs 1, 4, 3, 2, or 4, 1, 3, 2: first pair more robust than the others, often, in the males, its femur and tibia dilated. Tibia and patella of the third plainly shorter than tibia and patella of the fourth. Tarsus and metatarsus of the fourth of the same length as or scarcely shorter than patella and tibia. Tibial and metatarsal spines on the four pairs; less numerous, and only appearing at the extremities of the articulations on the posterior pairs.

*BIANOR N.

Syn: 1883. Scythropa KEYSERLING, Arachniden Australiens, p. 1446.

Cephalothorax a little longer than wide, sides rounded, before and behind equally contracted, high and convex, not wider than the dorsal row of eyes.

Clypeus low.

Quadrangle of eyes behind wider than long, in front contracted, reaching the middle of the cephalothorax. Anterior row substraight; the lateral a little separated from the middle eyes. Dorsal eyes further from one another than from the margin of the cephalothorax. The small median eyes are nearer the anterior lateral than the dorsal eyes.

---

* *Bianor* is substituted for *Scythropa*, the latter name being preoccupied.

ees vertical, not diverging.
xillae twice as long as the labium, dilated and rounded in front.
bium not longer than wide.
rnum twice as long as wide.
s 1, 4, 3, 2. First pair stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth; metatarsus and tarsus of the fourth a little shorter than the patella and tibia. Metatarsi of the fourth spined only at the apex.
domen oviform; one fourth longer than wide.
innerets as usual; superior and inferior equally long.

PIRITHOUS KEYSERLING. 1883.

: 1882. **Eulabes** KEYSERLING, Arachniden Australiens, p. 1387.
1883. **Pirithous** KEYSERLING, Arachniden Australiens, p. 1477.
phalothorax a little longer than wide, sides rounded, behind slanting and contracted, above moderately high and plane, wider at the dorsal row of eyes.
ypeus low.
adrangle of eyes wider than long, behind wider than in front, almost reaching the middle of the cephalothorax. First row of eyes strongly recurved, lateral eyes from the large middle eyes widely separated. small medium eyes further from the dorsal eyes than from the anterior lateral. Dorsal eyes further from one another than from the margin of the cephalothorax.
lces diverging.
xillae long, a little dilated in front.
bium longer than wide, not longer than half the length of the maxilla.
rnum small and a little longer than wide.
domen oval.
s spined, 1, 2, 4, 3, or 1, 4, 2, 3; first pair stouter than the others; patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth shorter than the patella and the tibia. Metatarsi of the fourth spined.
The generic name Eulabes was preoccupied.

[1] NEAETHA SIMON. 1885.

: 1869. **Attus** SIM., Monogr. d. espêces Europ. de la fam. d. Attides, p. 14 (24) (ad partem).
1871. " ID., Revis. d. Attid.
1876. **Neera** ID., Arachn. de France, III, p. 199.
1885. **Neaetha** ID., Etude sur Arachn. recueillis en Tunisie, Paris, Imp. Nat. 1885.

---

[1] Neatha = Neera, preoocupied.

Cephalothorax high; cephalic and thoracic parts of the same length; the latter very much inclined, contracted, truncated, or slightly hollowed.

Eyes: those of the face but little separated, forming a straight line. Dorsal eyes a little smaller than the lateral, not prominent, situated at the widest point of the cephalothorax, further apart than the lateral since the sides of the quadrangle diverge behind.

Clypeus almost half as wide as the middle eyes, with thick hairs.

Sternum oval, of the same width as the intermediate thigns.

Legs 3, 1, 4, 2, or 1, 3, 4, 2; first pair much more robust, with the femur compressed, dilated above, and claviform; patella and tibia of the first thick and cylindrical. Tibia and patella of the third much longer than tibia and patella of the fourth; metatarsus and tarsus of the fourth as long or scarcely shorter than the tibia and patella. Tibial and metatarsal spines on the four pairs; the metatarsus of the fourth having only a circle of terminal spines.

Falces vertical, not long.

CIRIS C. KOCH. 1848.

Syn.: 1848. **Ciris** C. KOCH, Die Arachn., 14, p. 85.
1850. " ID., Uebers. d. Arachn. Syst., 5, p. 69.
1877. " THORELL, Studi Ragni Malesi e Papuani, I., p. 283

Cephalothorax short, flat above, scarcely longer than it is wide.

Eyes of the face in a straight row.

Falces strong, thick, not long, wrinkled, shining, vertical.

Palpus of the female of not unusual form, the tarsus tapering oval.

Legs short, nearly equally long,

Abdomen very short, almost circular.

Spinnerets drawn in and scarcely visible.

Thorell remarks that Ciris is near to Ballus (C. Koch) and more especially to Neera Simon, in that the eye area is large, occupying one half the cephalothorax; while it differs from Neera in having the quadrangle of the eyes not wider, but a little narrower behind than in front, and the third pair of legs only a little longer than the fourth. Studi Ragni Malesi e Papuani, I, p. 285.

BALLUS (C. KOCH). 1850. SIMON.

Syn.: 1837. **Euophrys** C. KOCH, Uebers. d. Arachn. Syst., I, p. 33 (*ad partem.*
1846. **Marpissa** ID., Die Arachn. XIII, p. 53 (*ad partem*).
1850. **Attus:** sub.-gen. Ballus ID., Uebers. d. Arachn. Syst., 5 p. 68.
1869. " SIM., Monogr. d. Attid., p. 3 (16) 14 (24) (*ad partem*).
1870. **Ballus** THORELL, On Europ. Spid., I, p. 212.

1871. **Attus** SIM., Révis d. Attid.
1876. **Ballus** ID., Arachn. de France, III, p. 201.
1876. **Oedipus** MENGE, Preussische Spinnen, IX, p. 482.
1877. **Ballus** THORELL, Ragni Malesi e Papuani, p. I, 286.
1878. " LEBERT, Die Spinnen der Schweiz, p. 301.
1881. " THORELL, Ragni Malesi e Papuani, III. 665.
1882. " L. KOCH and KEYSERLING, Arachn. Australiens, p. 1335.

Cephalothorax flattened: cephalic and thoracic parts of the same length; the latter contracted, inclined, truncated or slightly hollowed behind.

Clypeus less than half as wide as the large middle eyes.

Eyes of the face sub-touching, forming a straight or barely curved line. Dorsal eyes of the same size as the lateral, not prominent, situated at the widest point of the cephalothorax, much further apart than the lateral.

Sternum attenuated at both extremities, a little wider than the intermediate coxae.

Falces short, plane, or a little flattened in front.

Palpus (♂) not very long, and not robust; tibia shorter than patella, with an external terminal apophysis, slender, tarsus oval, relatively narrow.

Legs short; the fourth pair longest, the first pair much the most robust, with femur and tibia much dilated, often flattened and claviform. Tibia and patella of the third much shorter than tibia and patella of the fourth; metatarsus and tarsus of the fourth usually shorter than tibia and patella. Legs of the two posterior pairs entirely without spines (except sænesiens); legs of the two first pairs having below two rows of tibial and metatarsal spines.

Integument covered with moderately long pubescence, simple, rarely scaly.

CHIROTHECIA TACZANOWSKI. 1878.

Chirothecia TACZANOWSKI, Bulletin de la Société Impériale des Naturalistes de Moscou, Tome LIII, 1878, No. 4, p. 362.

Cephalothorax low, flattened on the back; head much longer than wide, perfectly plane above; thoracic part shorter than the cephalic, a little lower behind.

Eyes of the third row placed very far back; those of the second row nearer the anterior than to the posterior eyes, and nearer each other than are the anterior and posterior lateral eyes. The tops of the anterior eyes are in a perfectly straight line; the middle eyes are very large, occupying the entire width of the face; the external eyes of this row are considerably larger than the eyes of the other rows.

Falces large, short and almost vertical in the female; long, horizontal, and armed with a long recurved hook in the male.

Legs ordinary and slender excepting those of the first pair which are thicker than the others, with the tibia enlarged and hollowed on its internal border to form a moderately deep groove; each of the borders of this groove has three long spines each articulated on an elevation which is low but much larger than the spine, and some irregularly distributed bristles; at the bottom of the groove is found a comb composed of wide, flattened hairs, which are crowded closely together, and disposed in a simple row.

Figure small.

This curious genus, in which the first legs are much thicker than the others, with the tibia greatly enlarged, resembling at the first glance the claws of crayfish and yet more those of chelifers, is characterized also by the extreme flatness of the cephalothorax, by the length of the cephalic part, and by the eyes of the last row being placed very far back.

COCALUS C. KOCH. 1846.

Syn.: 1846. Cocalus C. KOCH, Die Arachn., 13, p. 180.
1850. " ID., Uebers. d. Arachn. Syst., 5, p. 48.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 254.
1878. " ID., ibid., II, p. 283.
1881. " ID., ibid., III, p. 492.

Eyes of the first row all close together in a straight line. The two middle eyes are large, the outer, in diameter, scarcely half as large as the middle eyes; the eyes of the third row looking sideways, standing in a quadrangle with the first row, and as large as the lateral eyes of that row; the eyes of the second row only a little smaller than these, and placed half way between them.

Falces long, slender, vertical, cylindrical, with a rather short fang.

Palpus rather long, the first three joints slender, the fourth wide and short, the tarsus large, swollen, the bulb entirely covered; the bulb simple, with protuberances (einfach knotig), projecting a little forward.

The cephalothorax of this spider departs from all known species. The headplate forms an ascending slope from the first row of eyes, and ends in a roof-shaped ridge from which the thorax falls in a steep slope, to the hinder edge: the sides of the cephalothorax, however, are almost vertical, and therefore when looked at from above, it appears narrow. The abdomen is much narrower than the cephalothorax and cylindrical. The spinnerets are, in comparison with other genera, long and slender, the two upper and the two lower however, have but half the length of the two middle ones. The legs are rather long, the first and fourth pairs almost equally long, the second pair somewhat shorter than the first, and the third somewhat shorter than the second. All are rather slender.

[1] LINUS N.

L.: 1878. **Sinis** THORELL, Studi sui Ragni Malesi e Papuani, II p. 269.

phalothorax not much longer than wide, and very high, sloping steeply in front.

peus at least half as high as the middle anterior eyes.

rnum sub-ovate, wider than the coxae.

es: quadrangle rather large, occupying about ⅔ of the length of the cephalothorax, not much wider than long, a little narrower behind than in front, and but little narrower behind than the cephalothorax at that place. The anterior row of eyes, which is plainly visible when looked at from above, is a little curved upward. Middle anterior eyes very large, at least three times larger than the lateral eyes, and separated from them by only a small interval; eyes of the second row rather large, more than a third as large as the posterior eyes, and placed half-way between these, and the anterior lateral eyes; the posterior eyes, which are placed more than their own diameter higher than the anterior lateral eyes, are further from the lateral borders than from each other.

lces short, not.

xillae sub-ovate, diverging, narrow at the base, almost twice as long as the lip; lip a little longer than wide.

gs long, 1, 4 (in ♀ 4, 1), 2, 3, metatarsi and tarsi very narrow; first pair only a little more robust than the others, tibiae much longer than patallae; tibiae also spined above; posterior metatarsi with spines throughout their length.

domen sub-ovate.

innerets ordinary, two articulations, the superior the longer.

Type: S. fimbriatus (Dol.).

[This genus is nearly related to Cocalus (C. L. KOCH).

HYCTIA SIMON. 1876.

n.: 1869. **Marpissus** SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 7 (17) (ad part.).

1871. " ID., Rèvis. d. Attid.

1876. **Hyctia** ID., Arachn. de France, III, p. 18.

phalothorax elongated, almost parallel; thoracic part scarcely at all enlarged, at least a third longer than the cephalic part. Cephalic part flat, not inclined, limited by a wide depression, not deep, bent behind.

---

[1] *Linus* is substituted for *Sinis*, the latter name being preoccupied.

Eyes of the face very unequal, touching, at least the middle eyes, forming a straight line; dorsal eyes almost as large as the lateral, not further apart, the sides of the head thus being parallel; the square almost as long as wide; the dorsal eyes much further from each other than from the lateral borders.

Clypeus scarcely a third as wide as the middle eyes.

Sternum small, narrow, twice as long as wide, thighs longer than wide, those of the first pair much thicker and longer than the others, tou hing.

Legs 1, 4, 2, 3; first pair very long and robust; femur dilated and compressed; patella and tibia cylindrical, the latter always a third the longer; these two articulations longer (♂) or almost as long (♀) as the cephalothorax; tarsus and metatarsus slender, shorter than the patella and tibia; tarsus a third shorter than the metatarsus. [1] Second, third, and fourth legs short and slender. Tarsus and metatarsus of the fourth shorter, or almost as long as the patella and tibia. On the anterior pairs two inferior rows of tibiae and metatarsal spines; on the posterior pairs two inferior tibial spines, and one or two metatarsal spines.

Falces robust, longer than the face, (♀) vertical, (♂) lightly inclined forward.

Palpus (♂) slender; femur narrow and a little curved; tarsus oval, not large; bulb simply rounded above, prolonged into a point behind.

Abdomen narrow, elongated.

MITHION SIMON. 1884.

Mithion E. SIMON, Arachnides recueillis a Khartoum; Bulletin de la Société Zoologique de France, T. IX.

Cephalothorax much elongated, almost parallel; thoracic part at least a third the longer; cephalic part almost plane, little elevated, not inclined, with posterior depression lacking, or very slight.

Eyes of the face touching, with their tops in a straight line, extremely unequal, the median at least five times the larger, very convex and prominent. Dorsal eyes as large as the lateral, not, or scarcely further apart. Quadrangle as long as wide, parallel. Dorsal eyes much further from one another than from the lateral borders.

Clypeus having scarcely a quarter the diameter of the midde eyes.

Falces (♀) very short, almost square and vertical.

Sternum oblong oval, narrowing in front and behind, of the same width in the middle as the intermediate thighs. Thighs I separated by the width of the labium at the base, much thicker than the others; thighs II thicker than III; III and IV almost equal.

---

[1] Simon's description reads "first, third and fourth;" doubtless an error.

atella and tibia I shorter than the cephalothorax, tibia scarcely longer
a patella and as thick; tibia and patella IV a little longer than tibia and
ella III; tarsus and metatarsus IV almost as long as patella and
a; tibia IV at least a third longer than patella, cylindrical, neither attenu-
l or enlarged at the extremity. Spines short and serial on the tibiae
metatarsi I and II; slender on pairs III and IV; metatarsi III and IV
h a whorl of terminal spines; and with two or three small spines to-
d the middle; spinnerets very long, particularly the superior ones, cyl-
rical.

his new genus resembles Marpissa, and still more Hyctia, differing from
m in having the anterior thighs separated at the base by the width of
labium. It is closely related to the genus Icius E. S, but is distin-
shed from it by the quadrangle of the eyes being as long as wide and
allel, while in Icius it is plainly wider than long, and a little wider be-
d than in front, by the anterior median eyes being yet more large and
minent, and finally by the presence of several spines (one underneath
two internal lateral) on the posterior metatarsi, besides the terminal
le. It presents also a certain resemblance to the genus Thya, having
same kind of coloring, the scaly hairs, and the tufts of hairs in the
n of horns on the cephalothorax, but it is far removed from it by the
n of the cephalothorax and the proportions of the articulations of the
pairs of posterior legs.

MARPTUSA (THORELL), 1877. SIMON.

.: 1837. **Dendryphantes** C. KOCH, Uebers. d. Arachn.-Syst., 1, p. 31 (ad partem).

1846. **Marpissa** ID., Die Arachn., XIII, p. 56 (ad partem).

1869. **Marpissus** SIM., Monogr. d. Attid., p. 6 (16), 7 (17) (ad partem).

1870. **Marpessa** THORELL, on Europ. Spid., I, p. 213 (ad partem).

1876. **Marpissa** SIM, Arachn. de France, III, p. 23.

1877. **Marptusa** THORELL, Ragni Malesi e Papuani, I, p. 221 (ad partem).

1878. " ID., ibid., II, p. 24 (ad partem).

1878. **Marpessa** LEBERT, Die Spinnen der Schweiz, p. 201 (ad partem).

1878. **Marpissa** TACZ., Aranéides du Pérou, Bull. Soc. Imp. d. Nat. de Moscou, LIII, 4, p. 217.

1879. **Marptusa** L. KOCH, Arachnidea Australiens, p. 1092 (ad partem).

1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 432 (ad partem).

halothorax long; thoracic part a little dilated, at least a third the longer; cephalic part entirely plane, limited behind by a transverse depression.

Clypeus about half as wide as the middle eyes.

Eyes of the face rather unequal, forming a straight or scarcely curved line, a little separated; interval of the lateral wider than that of the middle, and yet not more than half their diameter. Dorsal eyes as large or almost as large as the lateral, a little further apart, since the sides of the head diverge a little behind; quadrangle at least a quarter wider than long; dorsal eyes much further from each other than from the lateral borders.

Sternum narrow, twice as long as wide. Anterior coxae almost touching, their interval much less wide than the lip; all the coxae longer than wide, those of the first pair thicker and a little longer than the others.

Palpus (♂) with the tarsus much enlarged in the form of a palette, and projecting beyond the bulb on all sides.

Legs of the first and second pairs equal or almost equal; those of the third and fourth a little shorter, equal or almost equal. First pair very robust; femur dilated and compressed; patella and tibia cylindrical, equal, or tibia barely longer (M. radiata ♂); these two articulations always shorter than the cephalothorax; tarsus and metatarsus more slender and shorter than patella and tibia; tarsus a little shorter than the metatarsus. Tarsus and metatarsus of the fourth shorter than the patella and tibia. Continuous inferior rows of tibial and metatarsal spines; tibial spines less numerous and less regular on the posterior pairs; usually the metatarsi of the fourth with only a terminal circle of spines.

In the Arachniden Australiens (p. 1093) Koch has used this genus in a different sense from both Simon and Thorell. The two latter define the clypeus as *about* half the middle eyes of the first row. Dr. Koch on the contrary extends the definition to include species where the middle eyes are equal to the clypeus or even overhanging the falces. Judging from the excellent figures which Koch gives, the spiders included in this genus form a very heterogenous group.

MENEMERUS SIMON, 1869.

Syn.: 1848. **Euophrys** C. KOCH, Die Arachn., XIII, p. 200 (ad partem).
1869. **Menemerus** SIM., Monogr. d. Attid., p. 6 (16), 196 (662).
1870. " THORELL, On Europ. Spid., I, p.214 (ad partem).
1870. **Marpessa** ID., ibid., p. 213 (ad partem).
1876. **Menemerus** SIM., Arachn. de France, III, p. 30.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p .228 (ad partem).
1878. " ID., ibid., II., p. 237 (ad partem).
1879. " L. KOCH, Arachniden Australiens, p. 1123.

1881. **Menemerus** THORELL, Studi Ragni Malesi e Papuani, III, p. 500 (ad partem).

1883. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1461.

1883. " SIM, Arachn., de l'Ocean Atlantique. Ann. Soc. Ent. de France, 1882, pp. 261, 284, 303.

Cephalothorax elongated; thoracic part a little dilated, at least a third the longer; cephalic part flat, or very slightly convex, limited by a wide and shallow transverse depression.

Clypeus scarcely half the anterior middle eyes.

Eyes of the face rather unequal, forming a line slightly curved (rarely straight), a little separated, particularly the lateral eyes. Dorsal eyes a little smaller (sometimes as large; M. falsificus) than the lateral, not further apart, since the sides of the head are straight; quadrangle a quarter or a fifth only (M. semilimbatus) wider than long; dorsal eyes as far from one another as from the lateral borders (M. semilimbatus) or further from one another.

Sternum almost twice as long as wide; attenuated in front. Anterior thighs separated by the width of the lip at the base; all the thighs longer than wide; those of the first pair the longest.

Legs (♂) 1, 4, 2, 3, or 4, 1, 2, 3; (♀) 4, 1, 2, 3. Legs of the first pair thickest; femur compressed; patella and tibia cylindrical, the latter longer (except M. falsificus); tarsus and metatarsus more slender and much shorter than the patella and tibia; tarsus shorter than the metatarsus. Tarsus and metatarsus of the fourth shorter than patella and tibia; patella and tibia of the fourth much longer than patella and tibia of the third: tibia of the fourth cylindrical and parallel. Tibial and metatarsal rows of inferior spines on the four pairs.

Palpus short; femur very much dilated, almost as wide as long; convex above; patella and tibia short and almost equal: tarsus rather small, very convex.

Abdomen oval, a little flattened.

This seems to differ from Attus only in the slightly lesser width in proportion to the length of the quadrangle of the eyes.

DENDRYPHANTES (C. KOCH), 1837. SIMON.

Syn.: 1837. **Dendryphantes** C. KOCH, Uebers. d. Arachn.-Syst., I, p. 31 (ad partem).

1850. " ID., ibid., 5 p. 60 (saltem ad partem).

1869. **Attus** SIM., Monogr. d. Attid., p. 6 (16), 14 (24) (ad partem).

1870. **Dendryphantes** THORELL On Europ. Spid., I, p. 214.

1870. **Marpessa** ID, ibid., p. 213 (ad partem).

1871. **Attus** SIM., Révis. d. Attid. (ad partem).

1876. **Dendryphantes** SIM., Arachn. de France, III, p. 35.
1878. " LEBERT, Die Spinnen der Schweiz, p. 303 (ad partem).
1878. " TACZ., Aranéides du Pérou *in* Bull. Soc. Imp. d. Nat. de Moscou LIII, 4, p. 309.
1880. " KARSCH, Arachnol Blättter VIII, Zur Keuntniss der Attiden, *in* Zeitsch. f. d. gessamt. Naturwissensch., LIII, p. 397.
1883. " SIM., Arachnides de l' Ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 260

Cephalothorax moderately high; thoracic part plainly dilated, at least a third the larger; cephalic part level, often a little limited by a transverse depression.

Clypeus less than half as wide as the large middle eyes.

Eyes of the face rather unequal, in a line considerably curved; the middle eyes not touching; the lateral separated by an interval often equal to half their diameter. The dorsal eyes almost as large as the lateral, a little further apart, since the sides of the head diverge behind. Quadrangle a third wider than long. Dorsal eyes further from one another than from the lateral borders.

Sternum elongated, rather narrow. Anterior coxae separated by the width of the lip, and much thicker than the others; coxae of the fourth pair a little longer than the intermediate pairs.

Falces robust and vertical in both sexes.

Palpus (♂) rather slender; patella longer than tibia; tarsus narrow, oval, truncated at the extremity.

Legs (♂) 1, 2, 4, 3, or 4, 1, 2, 3; (♀) 4, 1, 2, 3, or rarely 4, 1, 3, 2; the first and (som times) second pairs more robust with compressed femora. Tibia and patella of the first shorter than the cephalothorax; (♂) tibia longer: (♀) tibia and patella equal. Tibia and patella of the third much shorter than tibia and patella of fourth. Tarsus and metatarsus of the fourth plainly shorter than tibia and patella. Tibia of the fourth cylindrical and parallel; metatarsus of the fourth with only a circle of spines at the extremity.

PSECAS C. KOCH, 1850.

Psecas C. KOCH, Uebers. d Arachn. Syst., 5, p. 49.

Eyes like the genus Marpissa.

Falces rather long, cylindrical, vertical.

Palpus in the male rather short, the tarsus glossy, the bulb pointed at the extremity.

Head and thorax nearest in form to the genus Marpissa. The face in front is as low, and is scarcely higher than the middle eyes of the first

row. The falces are somewhat longer and in the only example that I have seen somewhat hidden under the palpus, so that the form is only imperfectly to be seen. The legs differ essentially from all the genera of the Salticidae, in that the tarsal joint is very short in proportion to the metatarsal. The legs are somewhat robust, the first and fourth pairs the longest and about equal in length, the second and third pairs growing somewhat shorter by degrees. The middle spinnerets are long, decidedly longer than usual, the others only half as long; in this the genus unites with Cocalus, to which altogether, it bears some likeness.

BŒTHUS THORELL, 1878.

Syn.: 1878. Bœthus THORELL, Studi sui Ragni Malesi e Papuani, II, p. 220.
1881. " ID., ibid., III., p. 431.

Cephalothorax short, high, sloping steeply in front, the cephalic part not narrower anteriorly.

Clypeus about $\frac{1}{4}$ as high as the middle eyes.

Sternum much wider than the coxae.

Eyes: quadrangle large, occupying more than $\frac{2}{5}$ (not indeed half) of the length of the cephalothorax, a little wider than long, wider in front than behind, where it is only a little narrower than the cephalothorax at that place. The anterior row of eyes, which is plainly visible when the cephalothorax is looked at from above, is only slightly curved upward; the middle anterior eyes are large, very prominent and sub-touching. the lateral much smaller, and a little larger than the posterior eyes, which are placed more than their own diameter higher than the lateral eyes, and are a little further from the lateral borders than from each other. Eyes of the second row rather large, placed almost in the middle between the posterior and the lateral eyes, and as high as the latter.

Falces as usual, sub-vertical.

Maxillae long and narrow, more than twice as long as the lip. Lip almost equally long and wide, widely truncated at extremity.

Legs moderately long, rather slender, 4, 1, 2, 3. First pair a little more robust than the others, tibiae and metatarsi with a few spines underneath, which are long and adpressed; tibia but little longer than metatarsus. Tibia with patella of fourth, longer than tibia with patella of third. Posterior metatarsi with spines throughout their length. The two tarsal claws moderate, not curved, slightly convex on the back, pectinated with many short teeth. Scopula dilated a little at the apex.

Abdomen long, a little flattened.

Spinnerets the superior, rather long, with two joints, which are conical, and at least as long as wide, the inferior ones sub-conical thicker and shorter than the superior.

Type: B. spinimanus.

In the general form of the body this genus stands about half-way between Attus (Walck) Thorell and Euophrys (C. Koch) Thorell, being distinguished from the former by its low clypeus, and from the latter by the posterior eyes being a little further from the margin of the cephalothorax than from each other; and agreeing in the form of the abdomen more with Marptusa Thorell; the form and armature of the first pair of legs, however, separates it widely from these genera; in this respect it is more like Synemosyna and Diolenius.

PLEXIPPUS (C. KOCH), 1845. KEYSERLING.

Syn.: 1846. **Plexippus** C. KOCH, Die Arachn., XIII, p. 93.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 262.
1878. " ID., ibid., II, p. 240.
1880. " KARSCH, Arachnol. Blätter, VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwissensch. LIII, p. 398.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 526.
1883. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1425.

Cephalothorax moderately high, descending steeply to the posterior border, slightly convex over the back, a fourth or a fifth longer than wide, gently rounded on the sides, and only a little wider at the third row of eyes.

Eyes of the face in a moderately bent row, the lateral half as large as the middle eyes and only slightly separated from them. The eyes of the third row smaller than the lateral eyes of the first row. The small median eyes nearer the anterior than the posterior lateral eyes. [1]The quadrangle longer than wide, and a little wider behind than in front, not reaching the middle of the cephalothorax. The eyes of the third row further from each other than from the lateral borders.

Sternum somewhat wider than the coxae of the second pair.

Falces rather long, stout, vertical, locked together, almost cylindrical, rough with transverse wrinkles, and having a dull lustre; the fang rather short and bent.

Lip not longer than wide.

Palpus rather long, somewhat slender; (♂) the tarsus scarcely longer than the metatarsus, but little swollen, with the extremity directed downward, and with a moderately large bulb.

---

[1]In all the species described by Keyserling under this genus the quadrangle is wider than long.

gs: patella and tibia of the third shorter than those joints in the fourth pair; metatarsus and tarsus of the fourth somewhat shorter, or more often as long as patella and tibia of the fourth. Spines on all the legs, those on the metatarsi of the fourth throughout their length.

In this genus the relative length of the legs is very variable. In the ecies described by Thorell (Studi Ragni, III, pp. 526-642) we find the llowing formulæ: ♂ 1, 3, 4, 2; 3, 4, 1, 2; 3, 1, 4, 2; 1, 3, 2, 4, $\overline{3\ 4}$ 1 2; 2, 3, 4; ♀ 3, 4, 1, 2; 1, 4, 3, 2; $\overline{1, 4, 3, 2}$. The same is true of the height the clypeus. In these species the height varies from less than ¼ to ⅓, ½ and in one spider almost equals the diameter of the large middle es.

[1] ZENODORUS N.

m.: 1881. **Ephippus** THORELL, Studi sui Ragni Malesi e Papuani, III, p. 643.

1883. " KEYSERLING, Arachniden Australiens, p. 1422.

phalothorax high, on both sides in front, especially in the male, dilated and inflated.

ypeus at least half as high as diameter of middle eyes. Quadrangle of eyes usually occupying ⅓ of the length of the cephalothorax, nearly equally wide in front and behind, about a quarter wider than long, and narrower than the cephalothorax at that place by three or four times the diameter of the posterior eyes. The line bordering on the upper edges of the anterior eyes is more or less strongly curved upward; the lateral anterior eyes separated by less than their diameter from the large middle eyes, eyes of the second row almost in the middle between the anterior lateral and the posterior eyes; posterior eyes further from the lateral borders than from each other.

ernum rather short, wider than the coxæ, not projecting between the coxæ of the first pair.

alces vertical, ordinary.

axillæ parallel, sub-ovate, at least half longer than the lip.

egs: third pair longer than the others (except in some males which have the first leg longer than the others), much longer than the fourth pair; patella with the tibia of the third longer than patella with the tibia of the fourth. (In the males the first pair of legs is enlarged, and densely haired, at least underneath.)

bdomen sub-ovate.

---

[1] *Zenodorus* is substituted for *Ephippus*, the latter name being preoccupied.

Spinnerets ordinary: the second joint of the superior, wider than long, and obtuse.

Type: Z. d'Urvillei (Walck.).

EURYATTUS THORELL. 1881.

Euryattus THORELL, Studi sui Ragni Malesi e Papuani III, p. 660.

Cephalothorax short, dilated anteriorly, not high.

Clypeus very low, not ¼ of the diameter of the middle eyes.

Eyes small; quadrangle very short, about twice as wide as long, and a little wider behind than in front. The anterior row usually curved upward, the middle eyes widely separated, the lateral eyes separated from the middle eyes by their own diameter; eyes of the second row a little further from the posterior eyes than from the anterior lateral eyes; the posterior eyes are placed much higher than the lateral anterior eyes, and are as far or farther from each other as from the lateral borders.

Sternum not much wider than the coxae, not projecting between the coxae of the first pair.

Falces ordinary, sub-vertical.

Maxillae parallel, sub-ovate; lip longer than wide, rather widely truncated at the apex.

Legs those of the first pair longer than the others; the third pair not much longer than the fourth; tibia with the patella of the third longer than tibia with patella of the fourth. The tibiae have spines above; the posterior metatarsi have spines throughout their length.

Abdomen sub-ovate.

Spinnerets: ordinary, the second joint of the superior one being the shortest.

Type: E. porcellus (Thor.).

By the greater space, says Thorell, between the anterior middle and lateral eyes and by the line which touches the upper borders of the first row of eyes being straight and by the lowness of the clypeus this genus is easily distinguished from Ephippus Thorell.

PHIDIPPUS C. KOCH. 1846.

Syn.: 1846. **Phidippus** C. KOCH, Die Arachn., 13, p. 125.
1850. " ID., Uebers. d. Arachn.-Syst., 5, p. 53.
1864. **Crytonota** (sub.-gen. Phidippus) SIM., H. N. d. Araignées, p. 324 (*ad partem*).
1877. **Phidippus** THORELL, On Araneae of Colorado, Bull. U. S.
1878. " TACZ., Les Aranèides de Pèrou, Bull. de. la. Sociètè Impèriale des Naturalistes de Moscou, LIII, 4, p. 333.

Eyes: The first row rather strongly bent, the two middle eyes moderately large, somewhat smaller than is usual, near together, the outer ones in diameter scarcely half as large, placed somewhat away from the middle eyes. The eyes of the third row nearly as large as the outer eyes of the first row, on little hills; the eyes of the second row very small, near to the outer eyes of the first row.

Mandibles stout, standing away from each other toward the extremity, wrinkled transversely, somewhat shining; the fang nearly as long as the upper part of the mandible, strong and bent.

Palpus: That of the female rather long, not stout, entirely of the customary shape, well covered with long hairs; the male palpus moderately stout, shorter jointed, the tarsus oval, thick, bent, the bulb projecting strongly in front.

The species belonging to this genus are all handsome, the mandibles of all having more or less metallic reflections. The head is high, the sides dilated with a short angular plate. The thorax is short and steeply sloping, in most examples, when not rubbed one notices upright brushes or fringes of hair between the upper eyes. The abdomen is rather large in the female, but in the male narrower than the cephalothorax. The spinnerets do not stand far forward. The legs are rather stout, the two first legs the longest, particularly long in the male; the second and fourth pairs are about equally long, the fourth being a little the longer; the third pair is the shortest.

PHILÆUS THORELL 1870. SIMON.

Syn.: 1837. **Dendryphantes** C. KOCH, Uebers. d. Arachu, Syst., 1, p. 31 (ad partem).

1837. **Calliethera** ID., ibid., p. 30 (ad partem).

1846. **Philia** ID, Die Arachn., XIII, p. 54, 56.

1846. **Phidippus** ID., ibid., p. 125 (ad partem).

1846. **Plexippus** ID., ibid., p. 93 (ad partem).

1869. **Attus** SIM., Monogr. d. Attid, p. 6 (16), 14 (24) (ad partem).

1869. **Dendryphantes** ID., ibid., p. 168 (634), (ad partem).

1870. **Philæus** THORELL, on Europ. Spid., I, p. 217 (♂).

1870. **Attus** ID., ibid., p. 218 (♀).

1876. **Philæus** SIM., Arachn de France, III, p. 45.

1877. " KEYSERLING, Spinnen aus Uruguay. Vienna, 1877 78. p. 617.

1878. " LEBERT, Die Spinnen der Schweiz, p. 305.

1879. " L. KOCH, Arachniden Australiens, p. 1080.

1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der attitden, *in* Zeitsch, f. d. Naturwissensch, LIII, p. 397.

Cephalothorax very high; thoracic part dilated, at least a third the longer; cephalic part plane or slightly convex, inclined, limited by a very weak transverse stria.

Clypeus less than half as wide as the middle eyes.

Eyes of the face rather unequal, in a moderately curved line; the middle not touching; the lateral separated by an interval equal to half their diameter. Dorsal eyes almost as large as the lateral, scarcely further apart. Quadrangle at least a third wider than long. Dorsal eyes equally distant from each other and from the lateral borders.

Sternum long, rather narrow. Anterior coxae separated by the width of the lip, thicker than the others.

Falces robust, longer and often a little oblique in the males.

Palpus (♂) very slender; patella and tibia equal or the latter the longer, tarsus oval, narrow, obtusely truncated at the extremity.

Legs. (♂) 1, 2, 4, 3, (♀) 4, 1, 3, 2. Anterior pairs more robust. Tibia and patella of the first male almost as long, female shorter than the cephalothorax; male tibia longer, female tibia and patella equal; tarsus and metatarsus more slender and shorter than the tibia and patella. Tibia and patella of the third much shorter than tibia and patella of the fourth; tarsus and metatarsus of the fourth plainly shorter than patella and tibia (sometimes of the same length in the males). Metatarsus of the fourth armed with spines to the base. Tibia of the fourth cylindrical and parallel.

SIMAETHA THORELL. 1881.

Simaetha THORELL, Studi Sui Ragni Malesi e Papuani III, p. 520.

Cephalothorax short, high, the dorsum strongly convex longitudinally, above, toward the middle dilated and very wide, in front moderately wide, posteriorly very perceptibly narrower.

Clypeus low.

Eyes: area occupying about $\frac{2}{5}$ of the length of the cephalothorax; the quadrangle very wide, much wider than long, wider behind than in front; anterior row of eyes curved upward; middle eyes not touching, separated from the lateral eyes by an interval at least equal to their diameter; eyes of the second row further from the posterior eyes than from the anterior lateral eyes; posterior eyes not further from the lateral borders than from each other.

Sternum scarcely or not wider than the coxae of the first pair; these coxae separated by less than the width of the lip.

Legs (♂) 1, 4, 2, 3; rather robust, without many spines; legs of the first pair more robust than the others, femora compressed anteriorly and and strongly bent above; tibia with patella of the fourth leg longer than tibia with patella of the third.

Abdomen short.

pinnerets as usual, superior longer and more slender than the inferior; with two joints, which are sub-cylindrical, about as long as wide.

ype: S. thoracica.

This genus, says Thorell, agrees with Philaeus in the distance between e middle and lateral eyes of the first row, but differs from it especially the form of the cephalothorax; in the latter respect it approaches Bellus (L. Koch) and Homalattus (White), but differs from them since the adrangle of the eyes only occupies $\frac{2}{3}$, not $\frac{1}{2}$, the length of the cephathorax.

[1] THYENE SIMON, 1885.

m.: 1850. **Plexippus** C. Koch, Uebers d Arachn.-Syst. 5, p. 51 (ad partem.)
1869. **Attus** Sim., Monogr. d. espèces Europ. de la fam. d. Attides, p. 14, (24) (ad partem).
1871. " Id., Révis d. Attid.
1876. **Thya** Id, Arachn. d. France, III, p. 51.

ephalothraax but slightly elevated; thoracic part very strongly dilated and rounded, at least a third the longer; cephalic part plane and inclined, not limited behind; a very short and fine longitudinal stria between the dorsal eyes.

yes of the face very unequal, forming a line slightly curved; the median eyes not touching; the lateral eyes separated by an interval almost as wide as their diameter. Dorsal eyes scarcely smaller than the lateral, much further apart, since the sides of the head diverge behind; these eyes projecting widely above; quadrangle at least a third wider than long; dorsal eyes further from one another than from the lateral borders. *Clypeus* about half the diameter of the middle eyes.

ernum elongated, contracted in front; anterior thighs separated by the width of the lip; the two anterior pairs (particularly the first), the thickest; the fourth a little longer than the third.

egs (♂) 1, 3, 4, 2; (♀) 4, 3, 1, 2; first pair the most robust; femur compressed and claviform; tibia and patella very thick and cylindrical, male as long, female shorter than the cephalothorax, male tibia a little longer, female tibia and patella equal. Tibia and patella of the third at least as long as patella and tibia of the fourth (only by the greater length of the patella). Tarsus and metatarsus of the fourth a little shorter than the tibia and patella. Tibia of the fourth cylindrical and parallel. Short, robust, conical tibial and metatarsal spines on the two first pairs, forming inferior rows; spines equally short, more slender, and not serial on the posterior parts: metatarsus of the fourth provided with spines throughout the length.

---

[1] *Thyene* is substituted for *Thya*, the latter name being preoccupied.

Falces robust, short, conical and vertical in both sexes.

Palpus rather slender; tibia and patella almost equal; tarsus oval; narrow.

AMYCUS C. KOCH. 1846.

Syn.: 1846. **Amycus** C. KOCH, Die Arach., 13, p. 182.
1878. " TACZ, Araneides du Pérou, Bull. de la Soc. Imp. des Nat. de Moscow LIII, 4, p. 345.
1880. " L. KOCH Arachniden Australiens, p. 1170.

Eyes: the first row is high over the mouth and strongly bent, the two middle eyes large, the side eyes in diameter not half as large. The eyes of the third row just as large as the side eyes of the first; those of the second row very small, half way between these two.

Mandibles very long, nearly equally thick, somewhat curved on the inner corner of the extremity, toothed, the fang rather large.

Palpus: that of the male slender, the second joint bent, the third cylindrical, plainly longer than the fourth, the tarsus long in front, swollen, the bulb covered from above.

Cephalothorax short and very high, falling steeply from the cephalic plate, rather flat, with distinct elevations at the eyes; also the face is very high, but not equally high in the different species, and the first row of eyes high above the mouth. The abdomen is somewhat longer than the cephalothorax, narrow, oblong oval, and equally with the cephalothorax, (the latter, however, only partially) covered thickly with scaly hairs. The spinnerets are slender and rather long, the legs also are long; of these the third pair is the longest, then follows the first, then the second and after this the fourth.

One of the species described by C. Koch and all the Australian species described by L. Koch under this genus have the eyes of the second row nearer the anterior than the posterior side eyes and the legs 1, 3, 2, 4, not 3, 1, 2, 4. See note by Dr. Koch, p. 1170 of the Arachniden Australiens. The species placed in this genus by Dr. L. Koch seem to us (judging by his plates) to belong to at least two if not three different genera.

ASARACUS C. KOCH. 1846.

Asaracus C. KOCH, Die Arachn., XIII, p. 188.

Eyes form and position as in Phidippus.

Palpus of the male slender, rather long, the second joint long, gently, slightly bent, the third and fourth short, not longer than thick, the tarsus moderately long, humped at the proximal end, somewhat raised in knots, in the middle on the back somewhat contracted, the bulb covered from above.

Falces very stout, very iridescent, large, strong, convex in front, the sides somewhat widened into a corner, standing away from each other at the extremities, with a long, strong fang.

This genus has a likeness to the genus Amycus; but the palpus, and particularly the falces are differently shaped; also the third pair of legs is not so long as the last pair. The first pair was broken, in the only example that up to this time has come under my observation. Head, thorax, and abdomen agree with those of the above mentioned genus.

LIGONIPES KARSCH. 1878

Ligonipes KARSCH, Diagn. Attoid. aliquot nov. Novae Holl., *cet., in* Mittheil. d. Münchener Entom. Ver., 1878, p. 26.

Cephalothorax more than twice as long as wide, not high, level.

Eyes of the third row not far in front of the middle of the cephalothorax.

Legs of the first pair remarkable; femora, patellae, and tibiae very much dilated, compressed, the tibiae having stiff short hairs on the inner side, their form being that of a hoe. Second, third and fourth pairs more slender.

Abdomen narrow.

LIGURINUS KARSCH. 1878.

Ligurinus KARSCH, Diagn. Attoid. aliquot nov. Novae Holl., *cet., in* Mittheil d. Münchener Entom. Ver., 1878. p. 27.

The genus Ligurinus is much like genus Hyllus C. Koch, and yet is easily distinguished from it; the forehead is a little higher than the anterior eyes, and is so widely ornamented with dense oblique hairs that if the cephalothorax is looked at from above the eyes are entirely hidden.[1]

LYCIDAS KARSCH. 1878.

Lycidas KARSCH, Diagn. Attoid. aliquot nov. Novae Holl., *cet., in* Mittheil. d. Münchener Entom. Ver., 1878, p. 25.

Cephalothorax high, gradually descending in three parts, cephalic part level. Posterior part sloping obliquely, rounded on the sides.

Eyes: quadrangle wider than long; eyes of the first row touching, the lateral being about a quarter smaller than the middle eyes, but a little larger than the eyes of the third row; eyes of the second row the smallest of all.

Clypeus: middle eyes of the first row distant from the margin of the clypeus by a space which nearly equals their diameter.

Legs: anterior legs short, robust; posterior legs more slender, those of the third pair longest.

Abdomen looked at from above, almost triangular, pointed behind.

---

[1] The presence of dense hairs ornamenting the forehead, would seem to be so completely *adaptive* a characteristic as scarcely to be a sufficient basis upon which to found a genus.

MARATUS KARSCH. 1878.

Maratus KARSCH, Diag. Attoid. aliquot nov. Novae Holl., *cet., in* Mittheil. d. Münchener Entom. Ver., 1878, p. 27.

Cephalothorax not long, high.

Eyes: those of the third row, a little in front of the middle of the cephalothorax. Eyes of the second row half way between the posterior and the anterior lateral eyes. Quadrangle of the eyes a little wider in front than behind.

Legs slender.

Abdomen flat, with parallel sides, quadrangular, longer than wide. Body hairy.

MOPSUS KARSCH, 1878.

Syn: 1878. **Mopsus** KARSCH, Diagn. Attoid. aliquot nov, Novae Holl., *cet. in* Mittheil d. Münchener Entom. Ver, 1878. p. 31.

1881. " THORELL, Studi sui Ragni Mal. e Pap., III, p. 462.

Mopsus is very like the genus Ascyltus in appearance, but the clypeus is not dilated on the sides, is higher and not so wide, grows a little narrower above, and is covered above on the anterior cephalic margin and on the sides, with long, slender hairs.

Cephalothorax: Cephalic part higher and shorter than in Ascyltus. Thorax sloping obliquely behind the dorsal eyes.

Eyes: Those of the first row curved backward, touching, placed below the frons. Those of the second row placed further from the lateral eyes and a little within the quadrangle.

Falces nearly perpendicular to the face.

The species placed by Koch & Keyserling (Archinden Australiens, p. 330) in this genus were subsequently made the basis of the genus Sandalodes, Arachniden Australiens, p. 1476.

ASCYLTUS KARSCH. 1878.

Syn : 1878. **Ascyltus** KARSCH, Diagn. Attoid. aliquot nov. Holl., *cet. in* Mittheil. d. Münchener Entom. Ver., 1878, p. 29.

1881. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1319.

Cephalothorax not high, rounded, wider in front, narrow behind, cephalic part not inclined.

Clypeus transversely vertical on the sides, somewhat extended, forming an acute angle, dilated, the extreme edge of the dilatation ornamented with some long hairs.

Eyes of the first row placed in front of the forehead. Quadrangle wider than long.

Falces nearly straight; (♀) rounded, smaller. (♂) longer, a little flattened bove, sharp on the edges, diverging.

Legs:[1] first and second pairs more robust and longer than the others; third and fourth pairs more slender, shorter, having spines.

Abdomen narrower than the cephalothorax: elongated.

Spinnerets long.

HYLLUS (C. KOCH). 1846. KEYSERLING.

Syn: 1846. **Hyllus** C. KOCH, Die Arachn., xiii, p. 161.
1846. **Deineresus** WHITE, Ann. and Mag. of Nat. Hist., 18. p. 179.
1877. **Hyllus** THORELL, Studi Ragni Malesi e Papuani, I, p. 258.
1878. " ID., ibid II, p. 264.
1878. " TACZ., Aranéides du Pérou Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 336.
1882. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1339.

Cephalothorax low and flat, a fifth longer than wide, much wider at the third row of eyes, rounded behind, convex on the back.

Clypeus one fourth as wide as the large middle eyes

Eyes of the face in a line a little curved backward, lateral half as large as the middle eyes and separated from them. Eyes of the second row further from the dorsal than from the lateral eyes. Quadrangle wider than long, equally wide in front and behind, placed before the middle of the cephalothorax. Eyes of the third row further from each other than from the lateral borders.

Sternum moderately convex, a third longer than wide.

Falces large, long, somewhat curved, diverging; the fang very long, somewhat fine, very pointed; on the inner side, before the bent point, a little corner.

Maxillae rounded at the extremity.

Lip more than half as long as the maxillae, growing narrower toward the extremity.

Palpus (♂) slender, almost filiform, the second joint the longest and somewhat bent; the third and fourth equally long, both conical; the last joint bent; the bulb covered from above.

Legs (♂) 1, 2, 4, 3, (♀) 1, 4, 2, 3; the first legs much longer and thicker than the others, which are nearly equal. Patella with tibia of the third not longer than patella with tibia of the fourth; metatarsus with the tarsus of the fourth shorter than patella with tibia. Metatarsus of the fourth with spines throughout its length.

---

[1] **Ascyltus** pencillatus Karsch, has the legs (♂) 1, 4, 3, 2, (♀) 4, 1, 3, 2. L. Koch and Keyserling, Arachniden Australiens, p. 1319.

ICIUS SIMON. 1873.

Syn.: 1850. **Marpissa** C. KOCH, Uebers. d. Arachn.-Syst., 5, p. 47 (ad partem).
1850. **Icelus** ID., ibid, p. 55.
1869. **Attus** SIM., Monogr. d. Attid., p. 14 (24) (ad partem).
1870. **Marpessa** THORELL, on Europ. Spid., I, p. 313 (ad partem).
1871. **Attus** SIM., Révis. d. Attid.
1873. **Icius** ID.
1876. " ID., Arachn. de France, III, p. 54.
1877. " KEYSERLING, Spinnen aus Uruguay. Vienna, 1877-78, p. 621.
1878. " THORELL, Studi Ragni Malesi e Papuani, II, p. 283 (ad partem).
1879. " L. KOCH, Arachniden Australiens, p. 1127.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 461 (ad partem.)

Cephalothorax rather elongated; thoracic part parallel, or very slightly enlarged, at least a third the longer; cephalic part plane, slightly elevated, often inclined, limited by a transverse depression which is straight or slightly bent forward.

Clypeus scarcely a quarter as wide as the large middle eyes.

Eyes of the face very unequal, touching, or the lateral ones a little separated, forming a straight line. Dorsal eyes as large, or almost as large as the lateral, a little further apart since the sides of the quadrangle diverge very slightly behind; quadrangle only a quarter wider than long; dorsal eyes much further from each other than from the lateral borders.

Sternum contracted in front, scarcely wider than the intermediate thighs. Anterior thighs separated by the width of the lip, much thicker than the others; thighs of the second and third pairs equal, those of the fourth a little longer.

Falces (♀) short, rather thick, almost square, vertical; (♂) longer, a little inclined forward, their external border presenting an elevated, longitudinal ridge.

Palpus (♂) slender; tibia shorter than the patella, provided with a small superior external apophysis; tarsus narrow and long.

Legs (♂) 1, 4, 3, 2; (♂) 4, 1, 3, 2; those of the first pair more robust; tibia and patella at least a quarter shorter than the cephalothorax; tibia the longer, and slender. Tibia and patella of the fourth much longer than the tibia and patella of the third; tarsus and metatarsus, male, almost as long, female, sensibly shorter tibia and patella. Tibia of the fourth scarcely a quarter longer than the patella, cylindrical, and a little more slender at the extremity. Spines short, rather robust,

and serial on the tibia of the first; slender and very far apart on the second, third and fourth legs: metatarsi of the third and fourth having only terminal spines.

SANDALODES KEYSERLING. 1883.

Syn.: 1882. **Mopsus** KEYSERLING, Arachniden Australiens, p. 1333 (ad partem).
1882. **Acompse** ID., Arachniden Australiens, p. 1326 (ad partem).
1883. **Sandalodes** ID., " " p. 1476.

Cephalothorax scarcely a fifth longer than wide, moderately high, rounded on the sides, considerably wider than the third row of eyes, becoming gradually smaller behind and in front, ascending steeply from the posterior margin to the third row of eyes, the cephalic part sloping forward. The middle line is just behind the third row of eyes; the *clypeus* is one fourth as wide as the anterior middle eyes.

Quadrangle of the eyes wider than long, as wide in front as behind, reaching only to the first third of the cephalothorax. The first row moderately bent, and the eyes rather near together. The eyes of the second row half-way between the posterior and the anterior lateral eyes. The posterior eyes further from each other than from the lateral borders.

Falces vertical, not diverging, and short.

Maxillae widely separated at their extremities, only a third longer than the lip.

Lip longer than wide.

Sternum long and narrow, narrower than the coxae of the second pair.

Legs, 1, 4, 3, 2; all set with spines, the first pair thicker than the others. Patella and tibia of the third shorter than patella and tibia of the fourth; metatarsus and tarsus of the fourth also shorter than the patella and tibia of the fourth; metatarsus of the fourth with spines throughout its length.

Abdomen fully twice as long as wide.

This genus has great similarity to Icius, and is distinguished from that genus principally by its narrow sternum.

BAVIA SIMON. 1877.

Syn: 1877. **Bavia** SIMON. Amm. Soc. Entomol. de France, (5), vii. pp 60–62.
1879. **Acompse** L. KOCH. Arachniden Australiens, p. 1352.

Cephalothorax not very long; thoracic part a little longer, not dilated, rounded; cephalic part plane, but slightly elevated, almost a regular quadrangle; the swellings above the eyes strong.

Eyes of the face very unequal, almost touching, in a straight line. Dorsal eyes as large as the lateral, not further apart since the sides of the head are straight.

Clypeus scarcely a third as wide as the middle eyes.

Sternum scarcely wider than the intermediate thighs. Anterior coxae separated by the width of the lip, much longer and more robust than the others.

Falces rather short, a little projecting, not ridged.

Lip twice as long as wide.

Legs (♂) 4, 1, 2, 3, those of the first pair much more robust; patella and tibia of the first as long as the cephalothorax, tibia much longer than patella; patella and tibia of the fourth much longer than patella and tibia of the third, much more slender; tarsus and metatarsus of the fourth a little shorter than patella and tibia; patella and tiba of the third equal; tibia of the fourth much longer than the patella; trochanters of the fourth long and diverging. On the first pair two inferior rows of short and robust tibial and metatarsal spines; on the second pair a single row of two internal tibial spines coming near together at the top; on the third pair two rows of lateral spines; the anterior having a single one, the posterior two; all the patellae, the metatarsi of the third and fourth, and the tibia of the fourth completely unarmed.

This genus is near *Maevia* and *Icius*; it is distinguished from them by the form of the cephalothorax, of which the cephalic part is relatively much longer, and by the posterior legs, which lack spines on the tibiae and metatarsi.

MAEVIA (C. KOCH) 1848. SIMON.

Syn.: 1848. Maevia C. KOCH, Die Archn., XIV, p. 69 (ad partem).
1876. " SIM., Archn. de France, III, p. 60.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 241 (ad partem).
1878. " TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 227.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwissensch., LIII, p. 398.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 467 (ad partem).

Cephalothorax elongated, very high; thoracic part enlarged, at least a third the longer; cephalic part slightly convex, and a little hollowed between the dorsal eyes.

Clypeus narrow, rarely ⅓ as wide as the large middle eyes.

yes of the face very unequal, forming a straight or almost straight line; the middle touching, the lateral well separated. Dorsal eyes as large as the lateral, equally far apart, quadrangle scarcely a quarter wider than long. Dorsal eyes nearer one another than the lateral borders.

ernum almost rounded, wider than the intermediate coxae. Anterior coxae separated by at least the width of the lip.

ulces (♂) much longer than the face, vertical, parallel, a little diverging only at the extremity, cylindrical, not ridged.

ulpus (♂) short, resembling that of Heliophanus except the femar which is unarmed.

egs 1, 4, 3, 2; the first and second pairs a little more robust: tibia of the first longer than patella, these two articulations at least as long as the cephalothorax. Tibia and patella of the fourth much longer than tibia and patella of the third; tarsus and metatarsus, male, as long as patella and tibia. Posterior legs having only very few spines a terminal circle only on the metatarsus (sometimes however a pair of median spines on that articulation).

In the species placed by Thorell in this genus (Studi Ragni Malesi e Papuani, III, pp. 467-492) the legs vary as follows: (♂) 2, 1, 4, 3; 1, 4, 3, 2; 3, 1, 2; 4, 1, 3, 2; (♀) 4, 3, $\overline{1, 2}$. The firrt formula, 2, 1, 4, 3, makes the second leg the longest. Simon in his Arachnides de France, III, p. 1, gives one of the characteristics of the family Attide, "2d pair of legs never the longest." We find the variation in the clypeus of Thorell's species to be from scarcely ¼ to about ½ the height of the large middle eyes.

OPISTHONCUS L. KOCH. 1880.

Opisthoncus L. KOCH, Arachniden Australiens, p. 1184.

Cephalothorax longer than wide, high, declining toward the posterior, sides moderately rounded, cephalic part slightly contracted in front, having a smooth, low protuberance, between the third row of eyes, more or less prominently adorned.

Clypeus very low.

Quadrangle of eyes wider than long, behind and in front equally wide, or behind a little wider. First row of eyes almost straight or slightly curved, middle eyes close to the lower margin of the clypeus, close to each other, and moderately distant from the lateral. Second row of eyes smallest, and from the lateral eyes of the first row less distant than from the eyes of the third row, and placed either not higher, or only a little higher than these; eyes of the third row, more widely separated from each other than from the margin of the cephalothorax.

Sternum long, contracted.

Maxillae long, contracted at the base, dilated toward the anterior; anterior margin rounded.

Labium more than one half the length of the maxillae, contracted toward the anterior, apex truncated.

Legs 1, 2, 4, 3 or 1, 4, 2, 3: 2, 3, 4 of almost equal length. First pair of legs more robust than the others, and in the male much longer than in the female. Patella and tibia of the third pair shorter that these joints in the fourth pair; the patella with the tibia is longer than the metatarsus with the tarsus in the fourth pair.

VICIRIA THORELL. 1877.

Vicirla THORELL, Studi Sui Ragni Malesi e Papuani, I, p. 233.

Cephalothorax about a third longer than wide, moderately high.

Clypeus at least half as wide as the anterior middle eyes.

Sternum rather short, not twice as long as wide, wider than the coxae, not projecting between coxae of the first pair of legs, which are separated by at least the width of the lip.

Eyes: those of the first row plainly visible when the cephalothorax is looked at from above; this row slightly curved upward. Middle anterior eyes large, very prominent; the lateral eyes are rather small, and are separated by an interval greater than their own diameter from the middle eyes. Quadrangle of the eyes a little wider in front than behind, not occupying half the length of the cephalothorax, much narrower behind than is the cephalothorax at that place. Eyes of the second row minute, about in the middle, or a little in front of the middle, between the anterior lateral and the posterior eyes. Posterior eyes placed about their own diameter higher than the anterior lateral eyes, and further from the lateral borders than from each other.

Falces directed downward and more or less forward.

Maxillae long, diverging a little, and slightly curved outward, about half longer than the lip; lip nearly half longer than wide, plainly narrowing toward the rounded or sub-truncated extremity.

Palpus slender, in the female neither dilated nor flattened at the extremity.

Legs rather long, slender or moderately stout, first pair, at least in some cases, more robust than the others; third pair (sometimes excepting the first), longer than the others; tibia with the patella of the third longer, or at least not shorter than tibia with patella of the fourth. Tibiae much longer than patellae. Metatarsi of the fourth spined throughout their length.

Abdomen long and slender.

Spinnerets six, long and cylindrical.

Type: V. Pavesii.

Viciria differs from Maevia (Koch) Sim. in the tibia and patella of the third being longer or at least not shorter than the tibia and patella of the fourth, and in the gr ater prominence of the larg middle eyes, and the greater space between them and the lateral eyes.

EPIBLEMUM (HENTZ) 1882. THORELL.

Syn.: 1832. **Epiblemum** HENTZ, On North America Spiders, p. 108 (ad partem).
1837. **Calliethera** C. KOCH, Uebers. d. Arachn. Syst. I, p. 30 (ad partem).
1850. " ID., ibid, 5, p. 45 (ad max. part.).
1864. **Cyrtonota** sub-gen. Calliethera Sim., H. N. d, Araignees, p. 324, 327 (ad part.).
1868. **Calliethera** [Calletherus] ID., Monogr. d, espéces Europ. de la fam. d Attides, p. 6 (16) 180 (646 (ad max. part.).
1870. **Epiblemum** THORELL, on Europ. Spid. I, page 210.
1876. " LEBERT, Die Spinnen der Schweiz, p. 297.
1876. **Calliethera** SIM., Arach. de France, III, p. 62.
1883. " " " de l' ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 261.

Eyes eight, unequal, in three rows, the first composed of four, the two middle ones somewhat larger, the second composed of two very small ones placed nearer the third row, which is composed of two larger ones.

Falces very long, slender, horizontal, in both sexes, fang nearly as long.

Maxillae parallel, wide at base, narrow above the insertion of the palpi, cut obliquely on both sides toward the p int.

Lip conical.

Legs 1, 4, 2, 3 or 1, 4, 3, 2.

Type: E Scenicum (faustum) Cl.

When Hentz, in 1832, form d the genus Epiblemum, he founded it on Epiblemum faustum; while Koch in 1837 founded the genus Calliethera on Aranea scenica. E. faustum and A. scenica are undoubtedly identical. This species is probably a comparatively recent importation f om Europe. Hentz is wrong in saying that the falces are horizontal in both sexes. They are vertical in the female of E. faustum.

THIANIA C. KOCH. 1846.

Syn.: 1846. **Thiania** C. KOCH, Die Arachn., XIII, p. 171.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 251.

Eyes of the first row close over the front edge of the head. The two middle eyes of this row very large, occupying nearly the whole height of the head. The eyes of the third row smaller than the lateral eyes of the first row; the small median eyes placed a little beyond the middle, nearer the hind eyes.

Falces of the male somewhat short, rather flat above.

Palpus moderately long and somewhat stout, the two first joints as usual, the third and fourth very short, oval, the small bulb covered from above.

The species belonging to this genus resemble those of the genus Callietherа. Eyes, falces, and palpus, however, make a plain and constant division. The scaly covering of the abdomen is highly colored, taking the form of transverse bands.

HASARIUS SIMON. 1871.

Syn.: 1846. **Plexippus** C. KOCH, Die Arachn., XIII. p. 93 (ad partem).
1850. **Euophrys** ID., Uebers. d. Arachn. Syst., 5, p. 60.
1850. " sub-gen, Maturna ibid., p. 65.
1869. **Attus** SIM., Monogr. d. Attid., p. 14 (24).
1869. **Plexippus** ID., ibid., p. 177 (643).
1870. **Attus** THORELL, on Europ. Spid., I, p. 218 (ad partem).
1871. " SIM., Révis. d. Attid,
1871. **Hasarius** ID., ibid.
1876. " ID., Arachn. de France III, p. 77.
1880. " KARSCH, Arachnol. Blätter VIII, zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwis ensch. LIII, p. 398.
1881. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1272.
1883. " SIM., Arachn. de l' Ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 284.

Cephalothorax rather long, high. Thoracic part sensibly dilated, at least a third the longer. Cephalic part slightly convex and inclined, limited by a very faint depression, which is straight or bent forward.

Eyes of the face rather unequal, forming a line very slightly curved; the middle eyes scarcely separated, the interval of the lateral, wider. Dorsal eyes a little smaller or as large as the lateral, a very little further apart, since the sides of the quadrangle diverge a little behind; quadrangle at least a third wider than long; dorsal eyes a little further from each other than from the lateral borders.

Clypeus usually wider than half the middle eyes, with thick hairs.

Sternum elongated, rather narrow. Anterior thighs separated by the width of the lip; all the thighs longer than wide, those of the first pair thicker and sometimes longer than the others, which are almost equal.

Legs usually (♂) 1, 3–4, 2; (♀) 3–4, 1, 2; the first and second pairs more robust, with femoral joints compressed. Tibia and patella of the first a little shorter than the cephalothorax, these two articulations equal, or the tibia a little the longer; tarsus and metatarsus shorter, more slender, almost of the same length. Femora of the third and fourth equal; tibia and patella of the third a little longer than tibia and patella of the fourth or often of the same, length. Tarsus and metatartus of the fourth of the same length as the tibia and patella. Tibia of the fourth parallel, or slightly enlarged at the extremity. Femoral, tibial, and metatarsal spines on the four pairs; metatarsus of the fourth with spines throughout its length.

Falces as long or longer than the face, vertical, often deep set[1] in both sexes, never ridged.

Palpus (♂) robust and short (except H. Adausoui); tibia shorter than patella and provided with external apophyses; tarsus longer than the preceding articulations and wide (except H. Adausoni); bulb simple, reaching almost the extremity of the tarsus; hook rarely apparent.

The species described by Messrs. Koch and Keyserling under this genus have the following variations in the leg formula: female, 1, 2, 3, 4; 1, $\overline{2, 3, 4}$; 1, 4, 3, 2; 1, 3, 4, 2; 1, $\overline{2, 3}$, 4; 4, 3, 1, 2; 4, $\overline{3, 1}$, 2; male, 1, 2, $\overline{3, 4}$; 1, 3, 2, 4; 1, 3, 4, 2; 1, 4, 3, 2; 1, $\overline{4, 3}$, 2; $\overline{1, 4}$, 3, 2; 4, 3, 1, 2; $\overline{4, 3}$, 1, 2; 3, 4, 1, 2; 4, 1, 3, 2. In the same species the clypeus varies in height from $\frac{1}{3}$ to $\frac{1}{2}$ the large middle eyes. It is interesting to note that while in the species described by Keyserling there seems to be a very constant relation between the length of the whole body and the longest pair of legs, the length of the longest legs being only very little greater or less than the total length, H. chrysostomus, male, has its total length 7 mm., and its longest leg 11.6 mm. H. vittatus, male, a fair representative of the other species, has its total length 4.2 mm., and its longest leg 3.8 mm. The greater proportional length of the longest legs in H. chrysostomus is correlated with other structural modifications which seem to separate it from the other species of this genus. The same remarks are applicable also to H. lautus.

---

[1] The French word is "renfoncée."

PELLENES SIMON. 1876.

Syn: 1850. Euophrys: sub. gen. Pales C. Koch, Uebers. d. Arachn.-Syst., 5, p. 64.
1869 Attus SIM., Monogr. d. espèces Europ. de la fam. d. Attides p. 14 (24) (ad partem.)
1870. " THORELL, On Europ. Spid. I., p. 218 (ad partem).
1871 " SIM., Revis d. Attid.
1876. Pellenes SIM., Arcahn. de France, III, p. 90.

Cephalothorax rather long, high; thoracic part distinctly dilated, at least a third the longer; cephalic part sightly convex; inclined, limited by a depression which is bent forward.

Eyes of the face rather unequal, forming a line which is straight or slightly curved forward; the middle eyes but little separated; the interval of the lateral eyes wider. Dorsal eyes a little smaller than the lateral and further apart, since the sides of the quadrangle diverge behind. Quadrangle about a third wider than long. Dorsal eyes further from one another than from the lateral borders.

Clypeus at least half as wide as the middle eyes.

Stermum long; anterior thighs separated by the width of the lip and thicker than the others; the lateral almost equal, longer than wide.

Legs (♂) 1, 3, 4, 2; (♀) 3, 1, 4, 2; first legs much the most robust, with compressed femora; tibia and patella of the first shorter than the cephalothorax; male, these two articulations equal; female, tibia a little the longer, tarsus and metarsus more slender and shorter than the two preceding articulations. almost equal. Femur, patella, and tibia of the third much longer and a little thicker than the femur. patella and tibia of the fourth; tarsus and metarsus of the fourth generally a little shorter than the patella and tibia of the third strongly enlarged, from the base of the extremity tibia; tibia of the fourth almost parallel or a little enlarged. Femoral, tibial and metatarsal spines on the four pairs, very short, and serial on the tibiae and metatarsi of the first and second; metatarsus of the fourth, with spines to the base.

Falces as long, or a little shorter than the face. Vertical or inclined backward in both sexes.

Palpus (♂) robust and short; tarsus oval, wider and at least as long as the two preceding; bulb generally simple, reaching almost the end of the tarsus; tibia shorter than the patella, provided with a superior external apophysis, directed forward, usually received into a little depression of the tarsal border and hidden from above.

ERGANE KEYSERLING. 1881.

Ergane KEYSERLING, Arachniden Australians, p. 1260.

Cephalothorax longer than wide, a little wider in the middle than in front, behind rounded, above high and convex, sloping in front.

Clypens less than half the diameter of the large eyes.

Quadrangle ofeyes wider than long, placed before the middle of the cephalothorax, as wide iu front as behind. Dorsal eyes from one another and from the margin of the cephalothorax almost equally distant. Small median eyes half way between the dorsal eyes and the lateral eyes of the ffrst row. First row of eyes curved.

Sterum oblong.

Falces short and touching.

Maxillae dilated in front, not twice longer than the lip.

Legs spined. 1–3, 4, 2, 3, 1, 2, 4, 1, 4, 3, 2, or 4, 3, 1, 2. Legs of the first pair a little stouter than the others. Patella and tibia of the third longer than the patella and tibia of the fourth. The fourth pair has the metatarsus and the tarsus longer than the patella with the tibia.

Abdomen ovate, longer than wide.

Spinnerets, inferior and superior equally long.

PHYALE C. KOCH. 1846.

Syn.: 1846. **Phyale** C. KOCH, Die Arachn., XIII, p. 193.
1878. " TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 315.

Eyes of the first row bent, the two middle eyes nearly touching, very large, close over the front edge of the head, the side eyes of this row in their diameter not half so large as the middle eyes; the eyes of the third row somewhat smaller than the outer eyes of the first row and almost forming a square with them; the eyes of the second row unusually small, half way between the eyes of the third row and the outer eyes of the first row.

Falces short, stout, swollen, shining, scarcely longer than thick, fang not long.

Palpus of the female of the customary form, somewhat covered with short hair; that of the male unknown.

All high colored beautiful little spiders. The head is flat above and rather long, the cephalothorax usually nearly as long as wide; the sides of the cephalothorax are gently rounded, and steeply falling; the head is not much higher than the middle eyes in front, the clypens being narrow and somewhat retreating. The abdomen is usually oval, almost always rather

short, not thicker than cephalothorax. Cephalothorax and abdomen are closely covered with scaly hairs above, these giving the color. The spinnerets are very short. The legs are moderately long, the first and second pairs being the shortest, but the stoutest, usually having the femur thickened; they are about one and a half times as long as the thorax; the third pair somewhat exceeds the second in length, and the fourth is plainly longer than the second; above, the first joints, and in part the tipiae are covered with brightly colored scaly hairs; the hair of the other joints is fine and light, and the spines very fine.

JOTUS KEYSERLING. 1881.

Jotus KEYSERLING, Arachniden Australiens, p. 1243.

Cephalothorax about one-fifth part longer than wide, in front a little more contracted than in the middle, rounded behind, above high and convex.

Clypeus less than half the diameter of the large eyes.

Quadrangle of eyes wider than long, equally wide in front and behind and not occupying half the length of the cephalothorax. Anterior eyes near together, forming a row slightly curved upward. Small median eyes half way between the dorsal eyes and the lateral eyes of the first row. Dorsal eyes almost as far from each other as from the margin of the cephalothorax.

Sternum slightly convex, ovate, much longer than wide.

Falces short and diverging, in front commonly plane.

Maxillae rather long, in front dilated and rounded.

Labium more than half the length of the maxilla.

Legs moderately long, spined, 4, 3, 1, 2, or 4, 1, 3, 2, or 1, 4, 3, 2. First pair a little stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. The fourth pair has the metatarsus and tarsus not longer than the patella and tibia.

Abdomen longer than wide, rounded in front, behind pointed.

Spinnerets rather long, inferior and superior equally large and long.

HABROCESTUM SIMON. 1876.

Syn.: 1869. **Attus** SIM., Monogr. d. espéces Europ. de la fam d. Attides, p. 14 (24) (ad partem).

1871. " ID., Revis. d. Attid.

1876. **Habrocestum** ID., Arachn. de France, III, p. 131.

1882. " KEYSERLING, Arachniden Australiens, p. 1401.

Cephalothorax rather short, very high; thoracic part often convex, but slightly dilated on the side, only a third the longer. Cephalic part slightly convex, very much inclined, limited by a faint depression which is straight or bent forward.

Eyes: those of the face, rather unequal, but little separated, forming a line straight or slightly curved forward. Dorsal eyes a little smaller than the latteral, not further apart, little or not at all prominent above; quadrangle scarcely a third wider than long; dorsal eyes almost equally distant from each other and from the lateral borders. *Clypeus* about half as wide as the middle eyes.

Sternum small, long, narrower than the intermediate thighs. Interval between the anterior thighs less than the width of the lip at the base.

Legs 3, 4, 1, 2; the first legs like those of Æ lurops. Femur, patella and tibia of the third much longer than the same articulations in the fourth pair. Tibiae of the third and fourth much enlarged from the base to the extremity and a little compressed. Tarsus and metatarsus of the fourth as long as patella and tibia.

Falces weak, scarcely as long as the face, vertical or obliquely directed backward in both sexes.

Palpus short and robust as in Ælurops.

HELIOPHANUS (C. KOCH.) 1833. SIMON.

Syn.: 1833. **Heliophanus** C. KOCH, *in* Herr.-Schaeff, Deutschl. Ins., 119, 1, 2.

1837. " ID., Uebers. d. Arachn.-Syst., p. 29.

1864. " [**Heliophana**] SIM., H. N. d. Araignees, p, 332.

1868. " SIM., Monogr., d. espéces Europ. de la fam. d. Attides, p. 6 (16), 201 (667).

1868. **Callethera** [**Callietherus**] ID., ibid., p. 6 (16), 180 (646) (ad partem).

1870. " THORELL, Europ. Spid. I, p. 211.

1876. " SIM., Arach. de France, III, p. 140.

1878. " LEBERT Die Spinnen der Schweiz, p. 298.

Cephalothorax high; thoracic part dilated, at least a third the longer. Cepholic part slightly convex, a little inclined, limited by a depression which is usually wide, straight, or bent backward; thoracic part presenting indistinct diverging striae.

Clypeus scarcely one fourth as wide as the large middle eyes, without hairs.

Eyes of the face very unequal in a straight or slightly curved line; dorsa eyes a little smaller than the lateral and not further apart. Quadrangle a third or a quarter wider than long.

Sternum wider than the intermediate coxae, often unequal. Anterior coxae separated by the width of the lip at the base.

Falces rather robust, vertical, never ridged.

(♂) *Maxillae* wide at the extremity; their superior external angle presenting one or two conical projections.

(♂) *Palpus* short; femur, robust, armed below with a simple or bifid apophysis; patella long and a little convex; tibia shorter armed with external apophyses, slender and slightly developed; tarsus narrow and elongated, terminating in a point, projecting beyond the bulb.

Legs 4, 1, 2, 3, or 4, 1, 3, 2, slightly unequal. Tibia and patella of the first shorter than the cephalothorax; metatarsus more slender than tibia and patella of the fourth. Patella (alone) of the third as long and often a little more robust than patella of the fourth; tibia of the fourth almost parallel and cylindrical. Femoral, tibial, and metatarsal spines on the four pairs; no patellary spines.

CYRBA SIMON. 1876.

Syn.: 1869. Attus SIM., Monogr. d. espéces Europ. de la fam. d. Attides, 14 (34) (ad part)

1871. " ID., Révis d. Attid.

1876. Cyrba ID., Arachn. d. France, III, p. 165.

1883. " KEYSERLING, Arachniden Australiens, p. 1436.

Cephalothorax but slightly elevated; thoracic part not dilated, a little contracted, about a third the longer; cephalic part plane, inclined, limited by a very faint transverse depression, cut by a longitudinal stria.

Eyes: those of the face very unequal, almost touching, forming a straight line. Dorsal eyes scarcely smaller than the lateral, not prominent, and not further apart. Quadrangle almost a third wider than long; dorsal eyes further from each other than from the lateral borders. *clypeus* very narrow, with hair.

Sternum oval, wider than the intermediate thighs. Anterior thighs separated by at least the width of the lip; thighs of the fourth longer.

Legs 4, 1, 3, 2; first pair much more robust, particularly the femur and the tibia. Tibia of the first a little longer than the patella; the two articulations shorter than the cephalothorax; tarsus and metatarsus more slender and almost as long as the two preceding articulations. Tibia and patella of the third much shorter than the tibia and patella of the fourth. Tibia of the fourth almost parallel; tarsus and metatarsus of the fourth as long or almost as long as tibia and patella. Femoral, tibial and metatarsal spines on the four pairs; two patellary spines on the two posterior pairs.

Falces rather weak, vertical, of the same length as the face.

Palpus (♂) femur slender; tibia with apophyses; tarsus oval. (♀) Tibia and patella a little dilated; tarsus pointed.

The species placed by Keyserling in this genus have the legs 4, 3, 1, 2, or 4, 3, $\overline{12}$.

[1] ÆLURILLUS SIMON. 1885.

Syn.: 1850. **Enophrys** (Sub-gen. Dia) C. KOCH, Uebers. d. Arachn. Syst., 5, p. 64.

1869. **Attus** (6th gr.) SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 54 (44).

1870. **Ælurops** THORELL, on European Spiders, I, p. 219.

1871. **Attus** (6th gr.) SIM., Rèvis d. Attid.

1876. **Ælurops** ID., Arachn. de France, III, p. 134.

1876. " LEBERT, Die Spinnen der Schweiz, p. 309 (ad partem).

[2] ***Cephalothorax*** very high; thoracic part strongly dilated, twice as long as the cephalic. Cephalic part slightly convex, inclined, limited by a slight transverse depression, generally straight.

Clypeus as wide or almost as wide as the middle eyes.

Eyes of the face rather unequal, well separated, particularly the lateral, in a line so much curved that a straight line from the top of the middle eyes cuts the lateral eyes below the center. Dorsal eyes smaller than the lateral, further apart. Quadrangle at least a third (often more) wider than long. Dorsal eyes as near or nearer to one another as to the lateral borders.

Sternum long, very narrow, particularly in the males. Anterior coxae separated by about the width of the lip. Coxae of the first, second, and third pairs equal in length and thickness, and a little longer than wide; coxae of the fourth a little longer than the others.

Falces not very robust, shorter than the face, inclined backward in both sexes.

Palpus (♂) short and thick; femur compressed; patella and tibia short and almost equal; tibia always with two small superior external apophyses; tarsus wider, oval and a little compressed, passing beyond the bulb.

---

[1] *Ælurillus* is substituted for *Ælurops*, the latter name being preoccupied.

[2] This is Simon's definition of the genus Ælurops Thorell.

Legs 3, 4, 1, 2, or 3,4, 1, 2, rarely 4, 3, 1, 2. The two anterior pairs shorter and more robust; tibia and patella of the first equal and much shorter than the cephalothorax: tarsus and metatarsus almost equal, a little (scarcely in the males) shorter than the patella and tibia. Femur patella and tibia of the third, of the same length or scarcely longer than the same articulations in the fourth pair. Tibia of the third (and of the fourth, though less) enlarged from base to extremity; tarsus and metatarsus of the fourth as long as patella and tibia. Femoral, tibial and metatarsal spines on the four pairs; patellary spines on the third and fourth. Metatarsus of the fourth with spines to the base.

YLLENUS SIMON. 1869.

Syn.: 1869. Yllenus SIM., Monogr. d. Attid., 166 (632).
1870. " THORELL, On Europ. Spid., I, p. 219 (ad partem).
1876. " SIM., Arachn. de France, III, p. 127.
1878. " LEBERT, Die Spinnen der Schweiz, p. 313 (ad partem).

Cephalothorax rather long; very high; thoracic part strongly dilated, twice as long as the cephalic. Cephalic part slightly convex, inclined, limited by a very slight depression.

Clypeus almost as wide as the middle eyes, with thick hairs.

Eyes of the face quite unequal, well separated, particularly the lateral forming a line strongly curved, the summit of the middle eyes being on a level with the center of the lateral eyes, or very slightly higher. Dorsal eyes smaller than the lateral, and further apart, not prominent. Quadrangle at least a third wider than long; dorsal eyes further from each other than from the lateral borders.

Sternum short, narrower than the intermediate coxae. Interval between the anterior coxae not quite so wide as the lip. Anterior coxae thicker than the others; second, third and fourth coxae equal in thickness; fourth coxae longest.

Falces weak, shorter than the face, vertical in both sexes.

Palpus short, very robust and massive; patella and tibia well developed tarsus relatively small, often compressed and raised into a ridge.

Legs 4, 3, 1, 2; first and second pairs shorter and much more robust, particularly the first; tibia and patella of the first equal, and much shorter than the cephalothorax: tarsus and metatarsus equal and much shorter than patella and tibia; femur, patella and tibia of the third much shorter than the same articulations of the fourth pair. Tibia of the fourth a good deal enlarged from base to extremity, and compressed; tarsus and metatarsus of the fourth much shorter

than patella and tibia; trochant rs of the fourth leg very long, visible from above. Femoral, tibial and metatarsal spines on the four pairs; patellary spines on the third and fourth: metatarsus of the fourth with spines to base.

tegument entirely covered with thick pubescence.

Nearest Ælurops Thorell, agreeing with that genus in having the upper rt of the frons so prominent that the anterior eyes are hidden from ove; and differing from it in that the tibia of the fourth leg is at least long as the metatarsus with the tarsus.

SAITIS SIMON. 1876.

n.: 1869. **Attus** (gr. 10) SIM., Monogr. d. espèces europ. de la fam. d. Attides, p. 96 (562).

1876. **Saitis** SIM., Arachn. de France, III, p. 168.

1877. " THORELL, Studi sui Ragni Mal. e Pap. I, p. 225.

1882. **Thorellia** L. KOCH and KEYSERLING, Arachniden Australiens, p. 1352.

1883. **Saitis** ID., ibid., p. 1434.

phalothorax moderately long, almost parallel; thoracic part a third the longer, not dilated; cephalic part plane and a little inclined, limited by a very slight depression.

ypeus very obliquely inclined, scarcely half as wide as the middle eyes.

es of the face very unequal, scarcely separated, in a straight line. Dorsal eyes very convex, scarcely smaller than the lateral, and a little nearer together. Quadrangle a third wider than long; dorsal eyes further from each other than from the lateral borders.

ernum moderately wide, contracted in front. Anterior coxae separated by the width of the lip; fourth coxae a little the longest.

ulces a little shorter than the face, and narrower, not robust, and inclined.

gs (♂) 3, 4, 1, 2; the first and second pairs almost equal and much shorter than the others; (♀) 4–3, 1, 2. Tibia and patella of the first a third shorter than the cephalothorax and almost equal, of the same length as the tarsus and metatarsus which are equal. (♂) Femur, patella, tibia and metatarsus of the third longer and much more robust than those of the fourth pair, ornamented with long hairs, which are very thick and disposed in longitudinal lines; (♀) third and fourth legs a little more alike. Tibia and patella of the fourth a little longer than the metatarsus, tibia of the fourth longer than the patella, parallel and cylindrical. Very long femoral, patellary (♀ on the posterior pairs), tibial and metatarsal spines; on the fourth pair metatarsal spines throughout the length of the articulation.

ATTUS (WALCK.) 1805. SIMON.

Syn.: 1805. **Attus** WALCK., Tabl. d. Aran. p. 22 (ad partem).
1850. **Europhrys** C. KOCH, Uebers. d. Arachn. Syst., 5, p. 60 (ad partem).
1869. **Attus** SIM., Monogr. d. espèces europ. de la fam. d. Attides, p. 6 (16), 14 (24), (ad partem).
1870. " THORELL, On Europ. Spid., I, p. 218 (ad partem).
1870. **Ælurops** ID., ibid. p. 219 (ad partem).
1871. **Attus** SIM., Révis. d. Attidae (ad partem).
1876. " ID., Arachn. de France, III, p. 101.
1877. " THORELL, Studi sui Ragni Malesi e Papuani, I. p. 280 (ad partem),
1878. " ID., ibid. II, p. 290 (ad partem).
1878. " LEBERT, Die Spinnen der Schweiz, p. 306 (ad partem).
1881. " THORELL, Studi sui Ragni Malesi e Papuani, III, p. 509 (ad partem).

Cephalothorax high; thoracic part a little dilated, a third, or only a quarter (*A. saltator*) the longer. Cephalic part plane or a little convex, inclined forward, limited by a slight depression which is straight or slightly bent.

Clypeus equal to half the large middle eyes, or a little narrower, rarely wider (*A. floricola* ♂).

Eyes of the face rather unequal, a little separated, at least the lateral, and usually in a slightly curved line; dorsal eyes usually a little smaller than the lateral, as far or a little further apart; quadrangle scarcely a third wider than long; dorsal eyes equally far or a little further from each other than from the lateral borders.

Sternum elongated, as narrow as the intermediate coxae (except *A. attellanus* ♂).

Falces weak, vertical, as long or shorter than the face.

Palpus normal.

Legs 4, 1, 2, 3, rarely 1, 4, 2, 3; remarkable for the pre-eminence of the second pair over the third. Tibia and patella of the first as long (*A. Wagæ, frigidus*) or most often shorter than the cephalothorax; (♀) these two articulations equal; (♂) tibia longer; tarsus and metatarsus more slender (except *A. cingulatus*) and shorter (often barely) than the two preceding articulations. Fourth legs much longer than the third in all their articulations, principally the femur and the tibia; tibia at least a third longer than the patella, slightly enlarged from the base to the extremity and a little compressed; tarsus and metatarsus of the fourth much shorter than the patella and tibia (except some males: *A. floricola*, etc.). Femoral, tibial and metatarsal spines on the four pairs and throughout the length of the articulations.

PHLEGRA SIMON. 1876.

yn: 1850. **Euophrys** (sub-gen. Parthenia) C. KOCH, Uebers. d. Arachn.-Syst. 5, p. 65.

1869. **Attus** (9th gr.) SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 85 (551).

1870. **Ælurops** THOR., On European Spiders, I, p. 219 (ad partem).

1871. **Attus** (10th gr.) SIM.; Rèvis d. Attid.

1876. **Phlegra** ID., Arachn. de France, III, p. 120.

ephalothorax very long, parallel in the cephalic part, a little dilated beyond; thoracic part at least twice the longer. Cephalic part plane and inclined not, or barely limited behind.

yes: those of the face very unequal; the middle eyes almost touhcing; the lateral a little separated, forming a line almost straight, or perceptibly curved. Dorsal eyes a little smaller than the lateral eyes, not, or very slightly further apart. Quadrangle a quarter wider than long; dorsal eyes a little further from one another than from the lateral borders.

lypeus always more than half as wide as the middle eyes, often fully as wide (♂), with hairs.

ernum contracted in front, at least twice as long as wide, as wide or slightly wider than the intermediate thighs. Anterior thighs separated by the width of the lip; thighs of the first, second and third legs almost equal; those of the fourth longer.

egs 4, 1, 3, 2, or 4, 3, 1, 2. Tibia and patella of tha first at least a quarter shorter than the cephalothorax, these two articulations being equal in length and thickness, and a little longer than the tarsus and metatarsus, the latter being equal and more slender. Femur, tibia and patella of the fourth much longer than those of the third pair, exactly of the same length as the tarsus and metatarsus; tibia of the fourth much longer than the patella, slightly enlarged and compressed at the extremity. Posterior metatarsi armed to the base with very long spines.

ulces vertical or obliquely inclined backwards, shorter than the face in both sexes.

OEDIPUS MENGE. 1877.

n.: 1869. **Attus** SIM., Monogr. d. Attid., p. 6 (16) 14 (24) (ad partem).

1876. **Ballus** ID., Arachn. de France, III, p. 201 (ad partem).

1877. **Oedipus** MENGE, Preussische Spinnen, IX, p. 482.

phalothorax oblong; higher than wide between the dorsal eyes; the convex cephalic part inclined forward, the hind part descending abruptly. The forehead and large middle eyes are so oblique that from directly above only the upper margin of the eyes is visible.

The *clypeus* is still more oblique.

Eyes like those of Dendryphantes.

Legs also like Dendryphantes except that the femur and tibia of the first pair are more robust. Number of claw-teeth small.

Palpus (♂) with a sharp apophysis on the inner side of the fourth joint The palpal tube makes a single turn and then passes into the sac-like bulb. The point of the hook lies on a small tongue-shaped leaf.

Epigynum (♀) closely resembling D. rudis; the openings of the spermathecal tubes lie on the inner half of the chitinous arched enclosure and end, after many turnings, close to the outer half of the orifice.

Spinnerets like those of Dendryphantes.

The species live in moss under fallen leaves and bushes.

SCARTES MENGE. 1877.

Scartes MENGE, Preussische Spinnen, IX, p. 494.

Cephalothorax oblong; the cephalic part with the forehead widely projecting; higher than wide, rounded on the sides, sloping steeply behind, the margin marked with a slight furrow.

Clypeus strongly retreating.

The large middle anterior *eyes* stand forward, the lateral anterior in a curve, somewhat removed from them. The small median eyes and the hind side-eyes stand rather on the side than on the top of the head.

The *palpus* (♂) has on the lower edge of the inner side of the second joint a deep-lying hook shaped apophysis with one small and one large tooth at the end. The fourth joint has on the inner side a short leaf-like apophysis; the fifth joint is long and has a small oval depression for the palpal organ, and the forepart long and curved over, the end of the palpal organ has four rounded corners, and is extended at one corner into a long awl-shaped projection, which consists of the palpal tube (Eindringer) and the covering which accompanies it to the very point. The awl-shaped projection is at one place narrowed; the palpal-tube passes, after a short winding course into the sack-like bulb.

I have found the female only in the immature stage, where the epigynum shows only two openings for the future spermathecal tubes.

Abdomen oval. The whole body finely haired.

Legs 4, 3, 1, 2, with long slender claws and two pairs of spines on the metatarsi of both first legs.

Spinnerets with small tubes.

They live under heath plants.

EUOPHRYS (C. KOCH) 1834. SIMON.

yn.: 1834. **Euophrys** C. KOCH, *in* Herr.-Schaeff., Deutschl. Ins., 123, (ad part.:) 7, 8.
1837. " ID., Uebers. d. Arachn.-Syst., 1, p. 33 (ad partem).
1848. **Attus** ID., Die Arachn., XIV, (ad part.:) p. 44–49.
1850. " ID., Uebers. d. Arachn.-Syst., 5, p. 63 (ad partem).
1869. " SIM., Monogr. d. Attid., p. 6 (16), 14 (24) (ad partem).
1870. **Euophrys** THORELL, on Europ. Spid., I, p. 216, (ad partem).
1871. **Attus** SIM., Revis. d. Attid. gr. 15 (ad partem).
1876. **Euophrys** ID., Arachn. de France, III, p. 170.
1878. " LEBERT, Die Spinnen der Schweiz, p. 302.
1878. " TACZ, Araneides du Perou. Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 280.
1883. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1430.
1883. " SIM., Arachnides de l'Ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 261.

ephalothorax rather high; thoracic part dilated, a third or a quarter longer than the cephalic which is usually plane, little inclined, limited by a badly defined impression, cut by a small, very short longitudinal stria; thoracic part often having some diverging striae faintly indicated.

lypeus half the middle eyes, or wider, with, usually, sub-ocular, and longer buccal hairs; the latter are often rooted in a membranous part which separates the border of the clypeus from the falces.

yes of the face very unequal, forming a straight, or rarely, a slightly curved line; dorsal eyes of the same size, or a little smaller than the lateral, not or scarcely projecting, and not further apart, since the sides of the square are straight; square a quarter wider than long: dorsal eyes further from one another than from the lateral borders.

ternum oval, usually wider than the intermediate coxae. Anterior coxae separated by at least the width of the lip: coxae of the fourth pair longest.

alces weak, vertical or inclined backward (renfoncees), shorter than the face.

egs 4, 3, 1, 2 or 4, 1, 3, 2, rarely 1, 4, 3, 2. First and sometimes second pairs more robust than the others, particularly in the males, the femora being compressed and claviform. Patella and tibia of the first almost always shorter than the cephalothorax and slightly unequal: tarsus and metatarsus shorter and more slender than the two preceding articulations. Tibia and patella of the third (together) a little, (often scarcely) shorter than the tibia and patella of the fourth: tibia of the

third much shorter, and a little thicker, than tibia of the fourth; patella (alone) longer than patella of the fourth; tarsus and metatarsus of the fourth as long or scarcely shorter than patella and tibia; tibia of the fourth, slightly enlarged at the extremity and a little compressed. Femoral, tibial, and metatarsal, but no patellary spines.

ALCMENA C. KOCH. 1846.

Syn.: 1846. Alcmena C. KOCH, Die Arachn., XIII, p. 176.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Natur Wissensch., LIII, p. 397.

Eyes of the first row as in Euophrys. The eyes of the third row plainly smaller than the outer eyes of the first row, and further removed from them, the eyes of the second row very small, nearer to the outer eyes of the first row than to the eyes of the third row.

Falces in the male large, convex, smooth, twice as long as the face; in the female smaller.

Palpus without distinctive characteristic.

This genus stands very near to the genus Euophrys, but the position of the eyes and the large falces separate it essentially. Moreover the cephalothorax and abdomen are thinner, that is to say narrower and longer, and also are covered closely with shining scales, which give the color and marking. The female palpus has nothing unusual; that of the male I know only from young animals with immature bulbs; these are not different from those of Euophrys.

[1] HYPOBLEMUM. N.

Syn.: 1882. Acmaea KEYSERLING, Arachniden Australiens, p. 1420.
1883. Drepanephora ID., Arachniden Australiens, p. 1477.

Cephalothorax one-third or one-fourth longer than wide, sensibly contracted toward the front, behind rounded, wider at the dorsal eyes, rather low, slightly convex above.

Clypeus low.

Quadrangle of Eyes, wider than long, in front moderately contracted, not reaching the middle of the cephalothorax. First row of eyes curved upward; the lateral are separated by half their own diameter from the large eyes. Dorsal eyes are further from one another than from the margin of the cephalothorax, small median eyes are half way between the lateral anterior and the dorsal eyes.

Falces short.

Maxillae dilated and rounded in front.

---

[1] *Hypoblemum* is substituted for Drepanephora, the latter name being preoccupied.

abium contracted toward the front, a little longer than wide, scarcely longer than half the length of the maxilla.

ternum convex, one third longer than wide, toward the posterior dilated.

egs spined, 3, 4, 2, 1. Fourth pair more slender than the others. Patella and tibia of the third longer than the patella and tibia of the fourth; metatarsus and tarsus of the fourth not longer than the patella and the tibia, metatarsi spined throughout their length.

bdomen sub-ovate, twice as long as wide.

pinnerets moderately long, superior and inferior of equal length.

SELAOPHORA KEYSERLING. 1882.

elaophora KEYSERLING, Archniden Australiens, p. 1374.

ephalothorax not high, about one-third longer than wide, contracted in front, behind wide and rounded, scarcely wider than the dorsal row of eyes, convex above.

lypeus scarcely as high as half the diameter of the large eyes.

uadrangle of eyes wider than long, as wide before as behind, situated in front of the middle of the cephalothorax. Anterior row of eyes nearly straight, not touching. Small median eyes a little nearer the dorsal eyes than the lateral anterior. Dorsal eyes further from each other than from the margin of the cephalothorax.

alces short and not diverging.

axillae twice as long as the labium.

abium contracted in front and not longer than wide.

bdomen long.

egs spined 4, 3, 1, 2. Patella and tibia of the third shorter than patella and tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia.

SOBARA KEYSERLING. 1882.

obara KEYSERLING, Arachniden Australiens, p. 1365.

ephalothorax longer than wide, contracted toward the front, rounded behind, moderately high, cephalic part plane,

lypeus as high as the diameter of the large eyes.

uadrangle of eyes wider than long, wider behind than in front not so long as the half of the cephalothorax, anterior row of eyes a little curved upward, middle eyes not touching, lateral eyes separated from these; small median eyes half way between the anterior lateral and dorsal eyes; dorsal eyes from each not wider than from the margin of the cephalothorax.

alces rather long and slender, not diverging.

axillae wide at apex, contracted at the base.

Labium contracted in front, longer than half the length of the maxilla margin in front straight.

Sternum plane, rounded.

Abdomen long and contracted.

Legs spined, 1, 4, 2, 3 or 4, 3, 1, 2. First pair of legs scarcely stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia.

THEROSA KEYSERLING. 1882.

Therosa KEYSERLING, Arachniden Australiens, p. 1418.

Cephalothorax one quarter longer than wide, not contracted in front rounded behind, a little wider at the dorsal eyes, above convex.

Clypeus very low.

Quadrangle of eyes wider than long, wider in front than behind, and placed far in front of the middle of the cephalothorax. Dorsal eyes a little further from one another than from the margin of the cephalothorax. First row of eyes curved, close together; small median eyes half way between the anterior lateral and the dorsal eyes.

Falces short and not diverging.

Maxillae dilated and rounded in front.

Labium rounded in front and half as long as the maxilla.

Sternum twice as long as wide, contracted more in front than behind.

Abdomen long and contracted.

Legs spined 4, 3, 1, 2. First pair not shorter than the others. Patella and tibia of the third as long as the patella and tibia of the fourth; metatarsus and tarsus of the fourth not shorter than the patella and tibia.

MARGAROMMA KEYSERLING. 1882.

Margaromma KEYSERLING, Arachniden Australiens, pp. 1347, 1466.

Cephalothorax one fifth part longer than wide, contracted in front, behind wide and rounded, high above, wider at the dorsal eyes.

Clypeus half the diameter of the large eyes.

Quadrangle of eyes wider than long, forming a trapezium, contracted behind. Dorsal eyes almost as far from each other as from the margin of the cephalothorax. First row of eyes recurved and near to each other. Small median eyes further from the anterior lateral than from the dorsal eyes.

Falces short and not diverging.

Maxillae rather long in front, dilated and rounded.

Labium contracted in front, not more than half the length of the maxilla.

Sternum sligtly convex, a little longer than wide.

Abdomen short and ovate.

Legs spined, 3, 4, 1, 2. First pair not stouter than the others. Patella and tibia of the third a little longer than the patella with the tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia.

PROSTHECLINA KEYSERLING. 1882.

Prostheclina KEYSERLING, Arachniden Australiens p. 1368.

Cephalothorax one fifth longer than wide, contracted in front, a little wider and rounded behind, equally wide at the dorsal eyes.

Clypeus half the diameter of the large eyes.

Quadrangle of eyes scarcely wider than long, behind a little contracted and almost reaching the middle of the cephalothorax. Anterior row of eyes almost straight, eyes close together. Dorsal eyes from each other scarcely further than from the margin of the cephalothorax; small median eyes half way between the anterior lateral and the dorsal eyes.

Fulces short, not diverging.

Maxillae dilated and rounded in front.

Labium contracted in front, half as long as the maxilla.

Sternum oval and moderately convex.

Abdomen ovate.

Legs 4, 3, 1, 2 or 1, 4, 3, 2. Patella and tibia of the third as long as the patella and tibia of the fourth.[1] Metatarsus and tarsus of the fourth longer than the patella and tibia.

LAGNUS L. KOCH. 1879.

Lagnus L. KOCH, Arachniden Australiens, p. 1073.

Cephalothorax a little longer than wide, high; lateral and posterior, margins rounded. Cephalic part convex.

Clypeus low.

Quadrangle of eyes in front a little wider than long and wider than behind; first row of eyes recurved, close together, the median very large. Middle eyes equally distant from the lateral anterior and the posterior eyes. Eyes of the third row placed in front of the middle of the cephalothorax and less distant from each other than from the margin of the cephalothorax.

Maxillae dilated toward the front, lateral margin with the anterior margin being lengthened to form an angle.

Lip convex, contracted in front, longer than half the length of the maxilla, lip rounded.

[1] Written "third" but evidently a misprint for fourth.

Sternum hardly longer than wide, plane.

Abdomen long, sensibly narrowed toward the posterior.

Palpi (♂) elongated, equal in length to the first pair of legs.

Legs spined 1, 4, 3, 2, first pair stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth evidently longer than the patella and the tibia.

SCAEA L. KOCH. 1879.

Scaea L. KOCH. Arachniden Australiens, p. 1142.

Cephalothorax longer than wide, slightly contracted behind, high and convex, toward the anterior declining, third row of eyes high above the sides.

Quadrangle of eyes wider than long, equally wide in front and behind, and placed in front of the middle of the cephalothorax. Middle row of eyes as far from the lateral eyes of the first row as from the eyes of the third row and placed not higher than these; eyes of the third row further from the margin of the cephalothorax than from each other.

Sternum ovate cordate.

Abdomen broadly ovate.

Legs patella with the tibia of the third pair shorter than the same joints of the fourth pair. The metatarsus with the tarsus of the fourth pair are shorter than the patella with the tibia.

[1] BOOTES N.

Syn: 1882. Hadrosoma KEYSERLING. Arachniden Australiens, p. 1418.

Cephalothorax short, one-sixth longer than wide, in front not contracted, behind rounded and a little contracted, scarcely wider at the dorsal eyes, above convex.

Clypeus more than half the diameter of the large eyes.

Quadrangle of eyes wider than long, as wide before as behind, almost reaching the middle of the cephalothorax. Dorsal eyes further from one another than from the margin of the cephalothorax. Small median eyes half way between the anterior lateral and the dorsal eyes. First row of eyes slightly recurved and the lateral eyes separated from the middle eyes.

Falces short and not diverging.

Maxillae dilated and rounded in front.

Labium rounded in front, not longer than wide, half as long as the maxilla.

Sternum oval and a little convex.

Abdomen level, a little longer than wide.

---

[1] *Bootes* is substituted for Hadrosoma, the latter name being preoccupied.

Legs spined 4, 1, 3, 2. First pair not stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsu and tarsus of the fourth not larger than the patella and tibia.

CYTÆA KEYSERLING. 1882.

Cytæa KEYSERLING, Arachniden Australiens, p. 1380.

Cephalothorax one-third or fourth part longer than wide, slightly contracted toward the front, behind rounded, a little wider at the third row of eyes, above slightly convex, not high.

Clypeus a third of the diameter of the large eyes.

Quadrangle of eyes wider than long, behind and in front equally wide or a little narrower behind, placed far in front of the middle of the cephalothorax. Dorsal eyes further from each other than from the margin of the cephalothorax. Anterior row of eyes recurved and more or less close together. Small median eyes half way between the anterior lateral and dorsal eyes.

Falces short and not diverging.

Maxillae dilated and rounded in front.

Labium rounded in front, not more than half as long as the maxilla.

Sternum oval, longer than wide.

Legs spined. 1, 3, 4, 2, or 4, 3, 1, 2; first pair stouter than the others. Patella and tibia of the third longer than the patella and tibia of the fourth; metatarsus and tarsus of the fourth not shorter than the patella with the tibia. Metatarsus of the fourth spined to the apex.

SINNAMORA KEYSERLING. 1883.

Syn.: 1882. **Tanypus**[1] KEYSERLING, Arachniden Australiens, p. 1415.
1883. **Sinnamora** ID., Arachniden Australiens, p. 1477.

Cephalothorax about one-fifth longer than wide, toward the posterior moderately dilated, contracted in front, a little wider at the dorsal row of eyes, above high, slanting before and behind.

Clypeus as high as one-fourth the diameter of the large eye.

Quadrangle of eyes wider than long, wider in front than behind, almost reaching the middle of the cephalothorax. First row of eyes recurved, close together. Dorsal eyes less distant from one another than from the margin of the cephalothorax. Small median eyes half way between the anterior lateral and the dorsal eyes.

Falces short, not diverging.

Maxillae dilated and rounded in front.

Labium longer than wide, more than half as long as the maxilla.

---

[1] The generic name "Tanypus" was pre-occupied.

Sternum rounded, plane and a little longer than wide.

Abdomen long and contracted.

Legs spined, 4, 1, 3, 2. First pair hardly stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth; metatarsus and tarsus of the fourth a little longer than the patella and the tibia. Metatarsus of the fourth commonly spined throughout its length.

LANUARULLA KEYSERLING. 1883.

Lanharulla KEYSERLING, Arachniden Australiens, p. 1431.

Cephalothorax one-fourth longer than wide, not wider in the middle than in front, scarcely wider at the third row of eyes, high and convex.

Clypeus very low.

Quadrangle of eyes wider than long, a little contracted behind, almost reaching the middle of the cephalothorax. Eyes of the first row close together, slightly curved or almost straight. Dorsal eyes a little smaller than the anterior lateral and further from one another than from the margin of the cephalothorax. Small median eyes are nearer the anterior lateral than the dorsal eyes.

Sternum heart-shaped, scarcely longer than wide.

Falces vertical, short, and not diverging.

Maxillae more than twice as long as the labium.

Labium **wider than long, rounded in front.**

Legs **4, 1, 3, 2. First pair not stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia. Matatarsi of the fourth pair spined only at the apex.**

Abdomen **short, as long as wide.**

Spinnerets **as usual, superior not longer than the inferior.**

ASTIA KOCH. 1879.

Astia L. Koch. Arachn. Australiens, p. 1152.

Cephalothorax **contracted in front, wider and rounded toward the posterior, opposite the third row of eyes wider, one quarter longer than wide.**

Quadrangle of eyes **wider than long, forming a trapezium contracted behind. Third row of eyes as far from one another as from the margin of the cephalothorax. Middle row of eyes nearer the front lateral than the posterior eyes, and placed perceptibly higher than these.**

Sternum **ovate-cordate.**

Abdomen **ovate, truncated in front, sensibly contracted toward the apex.**

Patella **and tibia of third pair shorter than the patella and tibia of the fourth pair. Metatarsus with the tarsus of the fourth pair shorter than the patella with the tibia.**

SUB-FAMILY LYSSOMANAE.

LYSSOMANES HENTZ. 1832.

n.: 1832. **Lyssomanes** HENTZ. Silliman's Journal of Science and Arts XXI pp. 99–152.

1844. " " Journal Boston Soc. Nat. Hist., IV pp. 386–396.

1875. " " Occasional Papers Boston Soc. Nat. Hist. II. The Spiders of the United States, Edited E. Burgess, p. 48.

ıeliceres moderately strong; maxillae parallel, short, rounded.

ip conical, slightly truncated at tip.

yes eight, unequal in four rows, the first composed of two very large eyes the second of two smaller ones, placed farther apart, on a common elevation with the two forming the third, which is narrower, the fourth about as wide, composed of two eyes placed on separate elevations

eet, first pair largest, then the second, then the third, the fourth being the shortest.

JELSKIA TACZANOWSKI. 1872.

yn.: 1872. **Jelskia** TACZ., Aran. de la Guyane française, Horae. Soc. Ent. Rossicae, VIII. 1871, pp. 128–132.

1878 " ID., Aranéides du Pérou, Bull. de la Soc. Imp. des Nat. de Moscou, LIII. 4, p. 373.

ephalothorax long, with the cephalic part distinct from the thoracic, and higher.

yes eight, in four rows; the first pair very large, occupying the entire height of the face, very near together but not touching, directed forward; eyes of the second row half as large, situated above those of the anterior row, a little further back, and separated from each other so as to form an almost regular quadrangle with the anterior eyes; like them directed forward and a little upward; the eyes of the third row small, situated on the horizontal face of the back, nearer to one another than the others, and directed upward; those of the fourth row as large as those of the second, placed behind on the middle of the back, not quite so far apart as these last, directed obliquely backward.

Falces cylindrical, slender, short, and vertical, with the hook short and strongly bent.

Palpus long and slender; the femur as long as the tarsus; the patella and and tibia equal, as slender as the femur, and not so long; the tarsus long, passing considerably beyond the bulb, which is globular, terminating in a curved hook which is coverrd above by the tarsus.

Legs very long, slender, and unequal; relative length 1, 4, 2, 3; the first pair much longer than the others, between which the difference is slight.

Abdomen long, slender, cylindrical, with short spinnerets.

[1] EPEUS N.

Syn: 1877. Evenus SIMON, Am. Soc. Entomol de France, (5), vii, pp. 58-58

Cephalothorax moderately long; thoracic part scarcely the longer, plainly dilated and rounded, cephalic part plane, high behind, inclined in front, longer than wide.

Eyes: the median anterior eyes very large, almost touching, the entire width of the face; the lateral eyes much smaller, separated, further back, forming a second line. Dorsal eyes as large as the lateral, a little nearer together since the sides of the head converge behind.

Clypeus almost as wide as the radius of the median anterior eyes.

Sternum scarcely wider than the intermediate coxae, rounded above, anterior coxae separated by at least the width of the lip, of the same length as the others.

Falces short, vertical, not ridged.

Legs 3, 1, 2, 4, long, the three first pairs of equal thickness, the fourth pair more slender, patella and tibia of the first longer than the cephalothorax, tibia much longer than the patella; patella and tibia of the fourth much shorter than patella and tibia of the third, and more slender; metatarsus and torsus of the fourth at least as long as the patella and tibia; on the first two pairs two inferior rows of very long tibial and metatarsal spines; tibae and metatarsi of the two posterior pairs with slender spines throughout their length. Long tarsal claws, regularly bent, the external one provided with a series of five teeth, longer, more slender, equal, crowded together.

This genus makes the transition from the ordinary Attidae to *Lyssomanes* of Hentz.

ATHAMAS CAMBRIDGE, 1877.

Syn: 1877. Athamas CAMBRIDGE, Proc. Zool Soc., London, pp. 575-7.
1879. " L. KOCH, Arachniden Australiens, p. 1076.

Cephalothorax short, massive, quadrate. Very convex above; the side and hinder slope almost vertical.

---

[1] *Epeus* is substituted for *Evenus*, the latter name being preoccupied.

Eyes very unequal in size, disposed in four transverse lines of two each, and almost of same length.

Maxillae rather short, slighty divergent, and much the broadest at their extremities, which are rounded.

Lip short, small, and of a somewhat curviangular form.

Legs rather slender and moderately long; those of the first pair longest; and of the second pair shortest.

Abdomen small, short, oval, and sloping from its most convex part, near the margin to the spinners.

This genus is closely allied to *Lyssomanes* Hentz, as well as to *Jelskia* Tacz. It differs, however, from both in the shortness of the cephalothorax and also of the abdomen. From *Lyssomanes* Hentz it differs in the superior and inferior spinners being of equal length, whereas, in that genus, those of the superior pair are much longer, slender and three-jointed.

Dr. L. Koch's suggestion that Athamas is probably identical with Evenus of Simon (Arachniden Australiens, p. 1076), seems to us an error, since the genera differ in several characteristics. In Cambridge's genus the cephalothorax in front is very *convex*; the sides of the head are *parallel*, the clypeus as *wide* as the middle eyes of the first row; the first leg longest. In the genus of Simon, the cephalic part is *plane*, the sides of the head *converge* behind, the clypeus is only *one half* the diameter of the large middle eye; the third leg longest.

APPENDIX.

We give below definitions of those genera which have been formed since the completion of the preceding paper. Those of Mr. Simon and Count Keyserling we have translated with their notes. We wish, also, to refer to a genus which had heretofore escaped our notice, and of which we have not yet the definition. This is *Chalcoscirtus* Bertkau, formed for *Calliethera infima* E. Sim., cf. Ver. d. Nat. Ver., XXX, 1883, p. 207.

PSEUDICIUS SIMON. 1885.

Syn.: Attus AUCT (ad part.). Dendryphantes E. Sinn., Ar. Fr., III (ad part. *eucarpatus*, etc.) + Calliethera E. Sim., Ar., Karth., 1884 (ad p. *icioides*). Pseudicius E. Sim, Faune Arach. de l'asie Mérid., Bulletin de la Soc. Zool. de France, t. x. 1885.

Related to the genus *Icius* E. Sim., differing in having the eye area parallel above, and the falces in ♂ and ♀ not grooved in the outer sides: tibiae I and II unarmed, or with one spine (*P. badius*), or provided with two minute spines on the inner side; tibiae and metatarsi III and IV unarmed, (excepting with the ordinary terminal spines); ♂ with femur and tibiae I very stout.

I believe it necessary to create this genus for a certain number of species whose characteristics are intermediate between those of *Icius*, and those of *Dendryphantes* and *Calliethera*, but which does not agree entirely with any one of these. The cephalothorax is long and low as in *Calliethera* and *Icius*, the first row of eyes is equally straight, this being the point which separates these genera from *Dendryphantes*, the ocular quadrangle is parallel above, as in *Calliethera;* the armature of the anterior legs is very peculiar; the tibiae are unarmed with the exception of one or two small internal spines on the first pair, but the metatarsi have two pairs of small spines. The integument is covered with simple hairs, never with scales.

This genus has for its type *P.* (*Dendryphantes*) *encarpatus* Walck.; it includes beside, *P. badius* E. Sim., *P. picaceus* E. Sim, from the south of Europe, and *P.* (*Calliethera*) icioides E. Sim., from Khartoum.

PSEUDAMYCUS SIMON. 1885.

Amycus V. HASSELT, (*albomaculatus*) (non C. Koch nec L. Koch).
Pseudamycus E. SIM, Arachn. recueillis par M. Weyers à Sumatra, Ex. des Comptes-rendus de la Soc. Ent. de Belgique, 1885.

Very closely related to the genus *Ephippus* Thorell, the cephalothorax and eyes being almost the same, the falces being furnished with one strong tooth on the inferior margin of the groove, and with two, the second being the smaller, on the superior margin (in *Ephippus* the inferior has 1, and the superior 3 or 4 minute teeth), the metatarsi and tarsi III and IV being a little shorter than the patellae with the tibiae (they are a little longer in *Ephippus*), and the tibiae III and IV armed with a dorsal spine below the base.

The genus *Amycus* C. Koch (type *igneus*), found in South America, is easily distinguished by its clypeus being as wide as, or wider than the anterior eyes, and by the inferior margin of the falces being provided with from 3 to 5 teeth.

PTOCASIUS SIMON. 1885.

Ptocasius SIM., Arach. recueillis par M. Weyers, à Sumatra, Ex. des Comptes-rendus de la Soc. Ent. de Belgique, 1885.

Related to the genus *Hasarius*, the cephalothorax being almost the same, but the occular area being a little longer above, scarcely one fourth wider than long, parallel or barely wider behind, convex on both sides behind the eyes; eyes as in *Hasarius* excepting that those of the second row are more widely removed from the posterior than from the anterior eyes; labium more attenuated, falces with a pair of teeth (or a bifurcated tooth) on the inferior margin of the groove. which are very unequal, the first being much smaller than the second, the maxillae in the ♂ denticulated on the outer side behind the corner. Legs as in the genus *Hasarius* but with the tibiae and metatarsi I and II armed on both sides with lateral spines, tibiae I and II without dorsal spines, III and IV with a smaller dorsal spine placed behind the base, integuments covered with simple hairs, not with scales.

Equally near to the genus *Cytaea* Keyserl. (in L. Koch, Ar. Austr.) but differing from it in having the cephalothorax shorter and higher, by the superior margin of the falces being provided with two teeth, as in *Hasarius*, while in *Cytaea* there are four small ones, by the two teeth of the inferior margin being very unequal, and finally by the integument being covered with simple hairs, while the *Cytaea* of the hairs are scale-like.

Salticus sinuatus Doleschall (*Plexippus* Th.), *Plexippus laticeps* Thorell, and probably many other species described by Dr. Thorell under the generic name of *Plexippus* belong to the genus *Cytaea*.

It is probable that several of the species described by Keyserling under the name of *Hasarius*, belong in the genus *Ptocasius*, particularly *lineatus*, *albocinctus*, *insularis*, *chrysostomus*, and *mulciber*, which are unknown to us.

STAGETILLUS SIMON. 1885.

Stagetillus E. SIM., Arach. recueillis par M. Weyers à Sumatra, Ex. des Comptes-rendus de la Soc. Ent. de Belgique, 1885.

Near the genus *Bavia*, but having the cephalothorax much longer; the thoracic part almost ⅓ longer than the cephalic, the ocular area longer above, a little narrower behind than in front, the sternum plainly wider than the intermediate coxae, and very much narrower in front, the space between the anterior coxae not narrower than the width of the labium, legs 1, 4, 2, 3, the first much stouter that the others, and compressed, tibiae and metatarsi I and II furnished with stout spines disposed in two inferior rows, the posterior legs unarmed, the metatarsi with the tarsi III and IV longer than the patellae with the tibiae, trochanter IV cylindrical and long, scarcely shorter than the coxae, falces short, parallel, almost plane in front, the inferior margin of the groove with 3 or 4 teeth.

AGOBARDUS KEYSERLING. 1885.

Agobardus KEYSERLING, Neue Spinnen aus Amerika, VI, p. 33.

Cephalothorax about ⅕ longer than wide, nearly vertical on the sides, narrower in front and behind, and not wider than the third row of eyes, very convex above, falling steeply to the posterior border, and having the cephalic part strongly inclined forward.

Quadrangle of the eyes equally wide in front and behind, and much wider than long, reaching behind to the middle of the cephalothorax. Looked at from in front the first row of eyes seems to be strongly curved, and the side eyes to be separated from the middle eyes by more than their own radius. The small eyes of the second row are about halfway between the fore side eyes and the eyes of the third row, which are equally distant from each other and from the lateral borders.

Falces a little diverging, and as long and stout as the patellae of the first pair of legs.

Labium not longer than wide, and only half as long as the maxillae, which are rounded in front and moderately wide.

Sternum only a little longer than wide, and plainly wider than the coxae.

gs (♂ 1, 4, 3, 2, and ♀ 4, 3, 1, 2), moderately long. the first pair scarcely stouter than the others, thinly haired and with spines on all the joints; the metatarsus of the fourth has several at the beginning and end. Metatarsus and tarsus of the fourth a little longer than patella and tibia of the fourth, and these joints as long as the patella and tibia of the third.

bdomen not much longer than wide.

WALA KEYSERLING. 1885.

ala KEYSERLING, Neue Spinnen aus Amerika, VI, p. 30.

bdomen long and slender.

phalothorax scarcely wider than long, strongly rounded on the sides, much wider than the third row of eyes, contracted behind, not high above, and rather flat. The cephalic part slightly inclined forward.

ypeus very low.

uadrangle of the eyes wider than long, somewhat narrower in front than behind, occupying only about $\frac{1}{4}$ of the cephalothorax. Anterior row slightly bent, with the eyes rather near together. Eyes of the third row further from each other than from the lateral borders.

ilces (♂) rather slender, long, and diverging.

ibium longer than wide, $\frac{2}{3}$ as long as the maxillae.

ernum scarcely longer than wide and scarcely narrower than the coxae of the first pair of legs, much wider than those of the second.

gs (♂) 1, 4, 3, 2, first pair in the male much longer and stouter than the others. Femur, tibia, and metatarsus of the first and second pairs with spines, which are found only on the femur and at the extremity of the metatarsus on the third and fourth pairs. Patella and tibia of the fourth longer than the patella and tibia of the third; also longer than the metatarsus and tarsus of the fourth.

This genus stands very near to *Hyllus* C. K., but is separated from it by e still shorter cephalothorax, by the absence of spines at the beginning the metatarsus of the fourth leg, and chiefly in that the patella and bia of the third are shorter than the patella and tibia of the fourth, and at the quadrangle of the eyes is a little wider behind than in front. It also somewhat like *Sandalodes* Keys., but is separated from it by the ort, wide sternum, and the absence of spines at the beginning of the etatarsus of the fourth. As to *Mospus Keruli* it offers, beside other fferences, the height of the clypeus in relation to the eyes, which is the incipal difference. (Bei *Mospus Keruli* bietet ausser anderen Verschieden- iten die Höhe des Clypeus das am meisten in die Augen tretende Merk- al der Unterscheidung).

GANESA PECKHAM. 1885.

Ganesa PECKHAM, Proc. Nat. Hist. Soc. of Wisconsin, March, 1885.

Cephalothorax very low and flat, slightly contracted in front and behind, twice as long as wide, and a little wider than the third row of eyes, with a depression limiting the cephalic part. Thoracic part twice as long as cephalic, truncated behind.

Eyes forming a quadrangle a little more than ¼ wider than long and equally wide in the front and behind. Anterior eyes all separated, forming a line slightly curved[1] downward, the middle nearly three times as large as the lateral eyes. Eyes of the second row halfway between the dorsal and lateral eyes. Dorsal eyes further from each other than the lateral borders.

Clypeus very low.

Sternum wide and oval, narrower behind than in front. Anterior coxæ separated by the width of the labium.

Maxillæ less than twice as long as labium, wider at the extremity, parallel.

Labium a little longer than wide, rounded at tip.

Falces nearly vertical, not diverging, robust, short, about as wide as long, narrower at the insertion of the fang.

Legs 1, 4, $\overline{2, 3}$, in both sexes. First leg much the stoutest, with the femur and tibia greatly enlarged, and patella slightly enlarged in both sexes. The patella with tibia of the third shorter than patella with tibia of the fourth; metatarsus with tarsus of fourth shorter than patella with tibia. The third and fourth pairs have no spines.

Abdomen long and slender, flattened above.

ASAMONEA (CAMBRIDGE). 1869. SIMON.

Syn, 1869. Asamonea CAMBR, Ann. Mag. nat. hist., 1869, p. 14.
1885. " E. Sim., Faune Arachnologique de l'Asie Mérid., Bull. de la Soc. Zool. de France, t X., 1885.

We transcribe the following remarks on the genus Asamonea, from E. Simon, (Materiaux pour servir a la faune Arachnologique de l'Asie Méridionale Bulletin de la Société Zoologique de France, t. X, 1885.)

---

[1] We speak of the anterior row of eyes as *straight* when a straight line from the top of the middle eyes touches also the top of the lateral eyes; *curved*, when a straight line from the top of the middle eyes cuts the lateral eyes; *curved downward*, when a straight line from the top of the middle eyes passes above the lateral eyes.

'he typical species *A. tenuipes* has been described by the Rev. O. P. ıbridge under the generic name of *Asamonea*, but the characters of genus have never been formulated, the author having been of the nion, even at the time of its publication, that this new genus was sim- synonymous with *Lyssomanes* Hentz. It seems to us that the genus ımonea ought to be re-established, as it differs greatly in reality from genus *Lyssomanes* by the proportion and the disposition of the eyes l the form of the labium; in *Asamonea* the region occupied by the six ssal eyes is much wider than long, and the eyes are almost equal, the rcely smaller ones of the third pair are placed much within and near se of the second, the labium is as wide as long, while in *Lyssomanes* dorsal ocular area is as long as wide or scarcely wider, the eyes of the rd row are much smaller than the others, placed equally far in, but ch more behind the eyes of the second row, finally the labium is much ger than wide.

'he characters of the genus *Asamonea* may be thus formulated:

'ephalothorax low almost plane above, dorsal eyes 2, 3, 4, occupy a peziform area much wider than long, eyes of the third row scarcely aller than the other eyes, and placed within and behind the eyes of the ond row. Maxillae short, almost quadrate. Labium not longer than le, a little attenuated and truncated. Superior spinnerets much longer n the inferior, biarticulate, the first articulation scarcely shorter than second. Legs slender, rather long, 1, 4, 2, 3, furnished with long spines; 'atarsus IV much longer than the tibiae.

SIMONELLA PECKHAM. 1885.

nonella PECKHAM, Proc. Nat. Hist. Soc. of Wisconsin, March, 1885.

dy long, slender, nodose.

phalothorax more than twice as long as wide, convex above, constricted near the middle; thoracic part twice as long as cephalic.

es very unequal in size, placed in four transverse rows of two each. those of the anterior row almost touching. The quadrangle formed by the second and fourth rows is wider behind than in front, and wider behind than long. Eyes of the third row very small, and nearer to the second than to the fourth row. Eyes of the fourth row on the upper margin of the cephalothorax.

peus less than ½ as wide as the anterior eyes, retreating.

rnum long, narrow behind. Anterior coxae separated by the width of the labium.

xillae twice as long as labium, widest in the middle, tapering toward apex.

bium as wide as long, truncated at tip.

ces stout and long, vertical, slightly diverging.

Legs 4, 3, 1, 2, slender, differing but little in thickness, the third and fou pairs unarmed. Patella with tibia of the third shorter than pate with tibia of the fourth; metatarsus with tarsus of the fourth shor than patella with tibia.

Abdomen long, slender, much narrower in the middle.

Including *Asamonea* Cambr., *Simonella* makes the sixth genus of sub-family Lyssomanae, which includes those attidae which have the e in four transverse rows. *Janus myrmaciaeformis* Tacz. is nearest to *S onella*, and Dr. Taczanowski, in describing that species, suggests tha ought to constitute a new genus. It differs, however, from *Simonella* that the first row of eyes occupies the whole of the face, and in the qu rangle of the eyes being longer than wide. *Simonella* is easily dis guished by its nodose form from the other genera of this sub-family. general appearance it most resembles *Synemosyna* Hentz.

PROCEEDINGS OF THE ACADEMY SINCE DECEMBER, 1881.

REPORT OF THE SECRETARY.

TWELFTH REGULAR ANNUAL MEETING,

Held at Madison, Wisconsin.

ROOMS OF WISCONSIN ACADEMY OF
SCIENCES, ARTS AND LETTERS,
CAPITOL, MADISON, WISCONSIN.

FIRST SESSION.

TUESDAY EVENING, December 27th, 1881.

Prof. Davies, General Secretary, read the minutes of the last meetings. Minutes were accepted and adopted.

Profs. W. F. Allen, E. A. Birge, and S. D. Hastings were appointed a committee to whom was referred all nominations for membership.

The Treasurer's report was then read and referred to a committee consisting of Profs. W. F. Allen, A. O. Wright, and R. C. Hindley.

The Treasurer also read the number of years that each member was in arrears for his dues, or also in advance upon his dues in virtue of the arrangement of dues made at the Eleventh Regular Annual Meeting; also the list of members who had failed entirely to respond to the demand for dues, was read.

Professors Butler and Birge and Hon. S. D. Hastings were appointed a committee to consider the legality of the

action of the Academy in appointing Prof. Davies, who has been for nine years General Secretary, and George P. Delaplaine who was for eight years Treasurer, of the Academy, Life Members, in virtue of long continued and unremunerated services in their respective offices.

Academy adjourned until 9 o'clock, Wednesday morning.

SECOND SESSION.

December 28, 1881.

Academy met at 9:30 A. M.

As the Secretary was unable to be present on account of sickness, Prof. A. Q. Wright was elected Secretary pro tem.

The committee on nominations reported, recommending the following persons:

Prof. E. G. Smith, Beloit College.

Prof. W. R. Higby, Lake Geneva Seminary.

F. J. Lamb, Esq., Madison.

Prof. R. D. Salsbury, Beloit.

Who were duly elected.

The following report was presented:

To the Wisconsin Academy of Jciences, Arts and Letters:

The committee to whom was referred the constitutionality of the resolution presented at the last Annual Meeting of the Academy, constituting Life Members of the Academy in consideration of some eight years of valuable official service, would respectfully report: that they do not regard the resolution as conflicting with the constitution, and they would therefore recommend its adoption.

Respectfully submitted,

SAMUEL D. HASTINGS,
E. A. BIRGE,
JAMES D. BUTLER.

MADISON, December 28, 1881.

This report was accepted and the resolution making General Delaplaine and Prof. Davies Life Members was then adopted.

The Auditing Committee reported approving the Treasurer's report.

Report adopted.

›rt adopted and the names so dropped are:

. W. F. Allen then read a paper on "Land Communi-
ıong the Ancient Germans."

. E. A. Birge gave a verbal account of a paper on
)istribution and Function of the Large Ganglion Cells
Frog's Spinal Cord."

. J. D. Butler read a paper on "Mediaeal German
s." Discussed by Prof. O. M. Conover and others.

. A. O. Wright, Secretary of the State Board of Chari-
ıd Reforms read a paper on "The Increase of In-
" Discussed by several.

ident Chapin gave a brief address relating to the
›f the Academy.

following resolution offered by the Treasurer was
d:

EAS, Thirty-one members of the Academy have this morning
pended from membership, for non-payment of annual dues under
ɜ of the Academy.

ed, That any of the persons thus suspended may be restored to
ship at any time by paying into the treasury the amounts due at
: of suspension.

Academy then proceeded to the election of officers
ıe following result:

ident — Prof. R. D. Irving.

-President of the Department of Science — Professor
)hamberlain, of Beloit.

-President of the Department of Letters — Professor
Sawyer, of Appleton.

etary — Prof. E. A. Birge, of Madison.

arian — Prof. A. O. Wright, of Madison.

ıtor of the Museum — Prof. R. C. Hindley, of Racine.

:surer — Hon. S. D. Hastings, of Madison.

. W. F. Allen proposed the following amendment to
ıstitution, which under the rules lies over until the
ıeeting.

ed, That the constitution be amended so as to abolish the Depart-
Arts.

election of Vice-President for the Department of Arts
ıspended.

The following resolution offered by Prof. W. F. Allen was adopted:

Resolved, That Secretary, Librarian and Curator compose a committee to have charge of the books and collections of the Academy.

The following resolution offered by Prof. R. C. Hindley was adopted:

Resolved, That the Academy favors and will foster to the best of its ability the establishment of Local, Literary and Scientific societies throughout the state.

Resolution offered by Prof. O. M. Conover was adopted, as follows:

Resolved, That the officers of the Academy be requested to unite with those of the State Historical Society in urging upon the Legislature at its next session the importance of providing a suitable fire-proof building for the use of the Historical Library and the collections of the Academy and of the other State Societies.

Academy adjourned for dinner.

THIRD SESSION.

Wednesday afternoon, 2:30 P. M.

In the lecture room of Natural History of Science Hall, University of Wisconsin.

President Irving in the chair.

The following papers by Rev. S. D. Peet, were read by title:

1. On Animism among the Emblematic Mound Builders.
2. On the Fetichism Exhibited in the Village Sites and Burial Places of Emblematic Mound Builders.
3. On the Tablets and Inscribed Plates of the Mound Builders of Ohio and Iowa compared with Aztec, Persian and Hindoo symbols.
4. The Theory that the Mounds of the Ohio Valley were the Foundations of Communistic Houses Refuted.

A paper was read by Mr. R. D. Salisbury, assistant to Prof. Chamberlin, of Beloit, on "The Dispersion of Drift Copper." Discussed by Professors Irving, Butler and Chamberlain.

Prof. Birge gave an extempore lecture on "Recent Ob-

tions on Nuclear Division and their Relation to Theo-
l Zoology."

:. Chamberlin then gave an interesting talk on
rican Glacial History in the Light of Recent Investi-
s," and the "Harmony of Certain Observations with
Hypothesis of the Origin of the Glacial Epoch."

George Schumm, editor of the *Radical Review,* read a
on "Proportional Representation in Legislation,"
was warmly discussed by many members.

following resolution was adopted:

ved, That the General Secretary be requested to prepare a corrected
the constitution and by-laws for publication in Volume V of the
ions, and that he also prepare for publication a copy of all resolu-
ich refer to the management of the affairs of the Academy that
of general interest to the members.

demy adjourned.

EVENING SESSION.

l in the senate chamber of the capitol.

rge audience greeted Prof. Butler, who kept his hear-
erested in his description of his "Visit to the Hawaiian
no." This paper was followed by a paper on "Human
y Empirically Considered," by Dr. John Bascom.

ourned.

THIRTEENTH REGULAR ANNUAL MEETING

Held at Madison, Wisconsin, December 26th, 27th and 28th, 1882.

ROOMS OF THE AGRICULTURAL SOCIETY,
TUESDAY, December 26th, 7:30 P. M.

The Academy was called to order by Pres. Irving.

The minutes of preceding meeting read and approved.

The Treasurer's report was given, as follows:

Balance on hand, 1881	$826 [illegible]
Received from annual dues	31 [illegible]
Received from life member (G. H. Paul)	100 [illegible]
Total	$957 [illegible]
Paid out on warrants	70 [illegible]
Balance December, 1882	$887 [illegible]

The report was referred to Mr. Lamb, Prof. Butler and Dr. Hoy, who reported favorably on it, and it was received and adopted.

The Publishing Committee reported the publication of Vol. V of the Transactions, that the state had furnished $90 for cuts, which sum was sufficient to pay the expenses of those in the volume.

The President and Secretary made brief verbal reports of matters in their respective offices.

The amendment to the constitution abolishing the Department of Arts was lost, (see p. 345).

The matter of publishing Vol. VI was referred to a special committee consisting of Profs. Irving, Wright, Allen and Dr. Hoy, and their report made the order of business for Thursday morning.

Dr. Hoy, Prof's. Allen and Peckham were appointed a committee on nominations.

Mr. S. W. Willard, of DePere, was elected as an annual member.

Capt. John Nader was unanimously elected Vice President for the Department of Arts.

Adjourned.

WEDNESDAY MORNING, 9:30.

President Irving called the Academy to order.

Messrs. C. R. Vanhise and Wm. Trelease, of Madison, were elected annual members.

Voted: that G. D. Swezey, of Doan College, Crete, Nebraska, have twelve copies of Vol. V., of the transactions.

Voted: that Dr. Hoy have six each of Vols. IV and V.

Voted: that parties applying for copies of the transactions be required to pay postage on the same.

Voted: that each contributor be entitled to eight copies of the volume wherein his paper appears.

Voted: that the Secretary prepare and send to each contributor with his proof sheets a blank to be filled out by him, indicating the number of extra copfes of the paper to be printed at the expense of the author.

Voted: that a committee of two be appointed to consider the formation of branch societies, to report Thursday evening.

Dr. Elmendorf and Prof. Emerson appointed as such committee.

The following papers were then read:

"Who Built the Mounds," and "Who made the Copper Tools," by Dr. P. R. Hoy, of Racine.

"The Mound Builders," by Dr. Day, of Wauwatosa. Discussed by Dr. Butler, Prof. Allen and others.

Mr. D. P. Blackstone, of Berlin, elected an annual member.

AFTERNOON SESSION.

2:30 P. M.

Vice President Sawyer in the chair.

Prof. Emerson's paper on Greek Religion was read and discussed.

Adjourned, 4:30.

EVENING SESSION.

Supreme Court Room, 7:30.

President Bascom in the chair.

Paper, "The Unity of Moral Ideas," by Rev. C. Cavern, of Lombard, Ill. Discussed by President Bascom and Mr. Richards.

Adjourned.

THURSDAY MORNING.

9:30.

President Irving in the chair.

Messrs. G. E. Brown, Madison, Wis.; D. H. Morgan, Albany, Wis.; R. G. Norton and S. Mills, Madison, Wis., elected annual members.

The committee on publication of Vol. VI reported and their report was unanimously adopted by article as follows:

RESOLUTIONS.

1. The Standing Committee on Publication are authorized to proceed at once to the preparation of Vol. VI of the Transactions of the Academy. Said volume to have its contents arranged according to meetings and not according to departments.

2. The Secretary of the Academy shall be charged with the special duty of overseeing and editing the publication of future volumes of the Transactions.

3. The Transactions of the Academy hereafter published shall contain: (*a*) a list of officers and members of the Academy; (*b*) the charter, by-laws and constitution of the Academy as amended to date; (*c*) the proceedings of the meetings; and (*d*) such papers as are duly certified in writing to the Secretary as accepted for publication in accordance with the following regulations, and no other:

(4.) Hereafter every author of a paper, whether it is to be read by title only, or in full, shall submit, at the time of reading, a brief abstract in writing, of the contents of the paper (not to exceed one half printed page in extent), which abstract shall in all cases be printed in full in the proceedings of the meetings of the Academy; and no paper shall be received for reading that is not accompanied by such abstract. Provided that for Vol. VI. of the Transactions the Secretary shall procure such abstracts of papers hitherto read.

(5.) Papers to be printed in full or in part in the Transactions must be requested of their authors by a Sub-Committee of the Standing Committee

on Publication, which Sub-Committee shall consist of the President and Secretary of the Academy and the Vice-President of the Department in which the paper falls; this Subcommittee to have the authority to request or publication portions only of papers, when it shall deem desirable to them to do so.

(6). In deciding as to the papers to be called for for publication, the committtee shall have spcial regard to its value as a genuine, original contribution to the knowledge of the subject discussed.

(7.) In case the committee shall not feel competent to decidc as to the value of a paper, on account of its special or technical character, it shall be their duty to call upon the author to agree with them upon some prominent specialist or specialists, whose opinion as to its value shall be asked, and shall decide the question of its publication.

8.) These resolutions shall not be construed so as to restrict the present freedom of members in reading papers before the Academy.

9.) The Sub-Committee on Publication shall be charged with insisting on the correction of errors in grammar, phraseology, etc., on the part of authors, and shall call the attention of authors to any other points in their papers, which in their judgment appears to need revision.

(10.) The Publishing Committee are authorized to expend not to exceed one hundred dollars for illustrations to Vol. VI of the Transactions.

ROLAND D. IRVING,
W. F. ALLEN,
P. R. HAY,
A. O. WRIGHT,
} Committee.

Papers read:

"The effect of local attractions on the Plumb line and Sea Level," Prof. J. E. Davies, Madison.

"Time and Tide," Capt. John Nader, Madison.

"Nature and Freedom," Prof. J. J. Elemendorf, Racine.

"Sorghum Sugar," M. S. Swenson, M. S., Madison.

Adjourned, 12:30.

AFTERNOON SESSION.

President Bascom in the chair.

Prof. Elmendorf read a paper entitled "The Ideal Man."

Prof. A. O. Wright read a paper on "Pauperism."

Prof. Allen read a paper on "The Sochemanni."

Read by title:

D. P. Blackstone, "The Variations in the attractions due to the figure of the attracting Bodies."

E. A. Birge, "Embryology of Panopaeus Sayi.'

THURSDAY EVENING.

7:30 P. M.

President Bascom's paper, "The Universality of Law," read and warmly discussed by many members.

Mr. Lamb was elected chairman of the meeting.

Report of the Committee on Branch Societies was accepted as follows:

Article one favoring the formation of such societies was adopted and the remainder was referred to a committee consisting of the council and Professors Elmendorf and Emerson to report at the next annual meeting.

Voted: that the Secretary of the Academy be and hereby is instructed to convey to the parties of the Supreme Court the thanks of the Academy for their kindness in opening the court room to its meetings.

Voted: that the Publishing committee be authorized to stitch and cover, at the expense of the Academy a sufficient number of the Transactions of each meeting when printed, to supply exchanging societies, if the same shall appear necesssary to said Committee.

Adjourned 9:30.

MEMBERS OF THE WISCONSIN ACADEMY OF SCIENCES ARTS AND LETTERS.

LIFE MEMBERS.

Dewey, Nelson, Cassville, Wis.
Davies, J. E., Madison, Wis.
Delaplaine, G. P., Madison, Wis.
Case, J. I., Racine, Wis.
Hoyt. John W., Wyoming.
Lawler, John, Prairie du Chien.
Mitchell, J. L., Milwaukee, Wis.
Paul, Geo. H., Milwaukee, Wis
Thorpe, J. G., Eau Claire, Wis.

ANNUAL MEMBERS.

Allen, Wm. F., Madison, Wis.
Allen, W. C., Racine, Wis.
Adsit, Mrs. C. D., Milwaukee, Wis.
Armsby, H. P., Madison, Wis.
Baetz, Henry, Milwaukee, Wis.
Bundy, W. F., Chicago, Ill.
Buck, J. S., Milwaukee, Wis.
Bate, Mrs. Amelia W., Milwaukee, Wis.
Buell, Ira M., Sun Prairie, Wis.
Birge, E. A., Madison, Wis.
Bartlett, E. W., Milwaukee, Wis.
Bascom, John, Madison, Wis.
Butler, J. D., Madison, Wis.
Bashford, R. M., Madison, Wis.
Beach, W. H., Madison, Wis.
Blackstone, D. P., Berlin, Wis.
Chamberlain, T. C., Beloit, Wis.
Chapin, A. L., Beloit, Wis.
Cass, J. E, Eau Claire, Wis.
Conover, Mrs. Sarah F., Madison, Wis.
Daniels, W. W., Madison, Wis.
Day, F. H., Wauwatosa, Wis.

Doyle, Peter, Prairie du Chien, Wis.
Draper, L. C., Madison, Wis.
Dudley, Mrs. Marian V., Milwaukee, Wis.
Elmendorff, Dr., Racine, Wis.
Emerson, Joseph, Beloit, Wis.
Fiske, E. O., Milwaukee, Wis.
Foye, J. C., Appleton, Wis.
Frankenburger, D. V., Madison, Wis.
Freeman, J. C., Madison, Wis.
Gapen, Clark, Madison, Wis.
Giles, Miss Ella A., Madison, Wis.
Gordon, Mrs. Geo., Milwaukee, Wis.
Greene, Thos. A., Milwaukee, Wis.
Holton, E. D., Milwaukee, Wis.
Hoy, P. R., Racine, Wis.
Hardy, Albert, La Crosse, Wis.
Heritage, Lucius, Madison, Wis.
Hastings, S. D., Madison, Wis.
Hutchinson, B. E., Madison, Wis.
Hindley, R. C., Racine, Wis.
Higley, W. K., Chicago, Ill.
Holden, E. S., Berkeley, Cal.
Irving, R. D., Madison, Wis.
Jones, Burr W., Madison, Wis.
Kerr, Alex., Madison, Wis.
King, F. H., River Falls, Wis.
Kumlin, Thure, Busseyville, Wis.
Lamb, F. J., Madison, Wis.
Lapham, Mary S., Oconomowoc, Wis.
Marks, Solon, Milwaukee, Wis.
McLaren, W. P., Milwaukee, Wis.
Meacham, J. G., Sr., Racine, Wis.
Meacham, J. G., Jr., Racine, Wis.
Morgan, D. H., Albany, Wis.
Morris, W. A. P., Madison, Wis.
Mills, Simeon, Madison, Wis.
Nader, John, Madison, Wis.
Norton, R. G., Madison, Wis.
Olin, Mrs. D. A., Racine, Wis.
Orton, H. S., Madison, Wis.
Peckham, G. W., Milwaukee, Wis
Peet, S. D., Clinton, Wis.
Perkins, H. B., Appleton, Wis.
Raymer, Geo., Madison, Wis.
Salisbury, R. D., Beloit, Wis
Sawyer, W. C., Oshkosh, Wis.

Smith, E. G., Beloit, Wis.
Sneiding, Henry, Racine, Wis.
Sprague, A. R., Racine, Wis.
Stair, W. P., Black Earth, Wis.
Swenson, Magnus, Hutchinson, Kan.
Tatlock ,John, Jr., New York, N. Y.
Trelease, Wm., Madison, Wis.
Van Hise, C. R., Madison, Wis.
Van Velzer, C. A., Madison, Wis.
Viebahn, C. Z., Watertown, Wis.
Westcott O. S., Racine, Wis.
Weyburn, L. A. Rockford, Ill.
Whitford, W. C., Milton, Wis.
Williams. S. W., West Depere. Wis.
Willis, Mrs. O. B., Racine, Wis.
Winship, E. B., Racine, Wis.
Wooster, L. C., Whitewater, Wis.
Wright, A. O., Madison, Wis.
Young, A. A., New Lisbon.

DECEASED MEMBERS.

Armitage, W. E., Right Rev. Bishop P. E. Church, Milwaukee, Wis.
Carpenter, S. H., LL.D., Prof. English Language, University of Wisconsin, Madison, Wis.
Conover, O. M., LL. D., Madison, Wis.
De Koven, J., S. T. D., Warden Racine College, Racine, Wis.
Dudley, Wm., Madison, Wis.
Eaton, J. H., Ph. D., Prof. Chemistry Beloit College, Beloit, Wis.
Engelman, Peter, Director German and English Academy, Milwaukee.
Feuling, J. B, Ph. D. Prof. Philology, University Wisconsin.
Hawley, C. T.. Milwaukee, Wis.
Lapham, I. A., LL. D., State Geologist, Milwaukee, Wis.
Little, Thos. H., Supt. Institution for the Blind, Janesville, Wis.
McDill, A. S., M. D., Supt. State Hospital for the Insane, Madison, Wis.
Nicodemus, W. J L., A. M. C. E. Prof. Engineering, Univ. Wis.
White, S. A., Hon., Whitewater, Wis.
Wolcott, E. B., M. D., Surgeon General, Milwaukee, Wis.

CORRESPONDING MEMBERS,

Abbott, C, C., M. D., Trenton, New Jersey.
Andrews, Edmund, A. M. M. D., Prof. Chicago, Medical College Chicago, Ill.
Barrow, John W. 113 Fast Seventeenth St., New York City.
Bridge, Norman, M. D., Chicago, Ill.

Benton, J. G., M. D., Philadelphia, Penn.
Buchanan, Joseph, M. D., Louisville, Ky.
Burnham, S. W., F. R. A. S, Chicago, Ill.
Byrness, R. M., M. E., Cincinnati, Ohio.
Carr, E. S., M. D., Supt. Public Instruction, California.
Caverno, Rev. Chas., Lombard, Ill.
Ebener, F., Ph. D., Baltimore, Md.
Fallows, Right Rev. Sam'l, Chicago, Ill.
Gatchell, H. P., M. D., Kenosha, Wis.
Gill, Theo., M. D., Smithsonian Institute, Washington, D. C.
Gilman, D. C., Pres. Johns Hopkins University, Baltimore, Md.
Harris, W. T., LL. D., Concord, Mass.
Hopkins, F. N., M. D., Baton Rouge, La.
Holland, Rev. F. M., Concord, Mass.
Horr, M. D., Pres. Iowa Institute of Arts and Sciences, Dubuque, Iowa.
Hubbell, H. P., Winona, Minn.
Jewell, J. S., A. M., M. D., Prof. Chicago Medical College, Chicago, Illinois.
Le Barron, Wm., State Entomologist, Geneva, N. Y.
Marcy, Oliver, LL. D., Prof. Northwestern University, Evanston, Illinois.
Morgan, L. H., LL. D., Rochester, Illinois.
Newberry, J. S., LL. D., Prof. Columbia College, New York,
Orton, E. A. M., Pres Antioch College, Yellow Springs, Ohio.
Paine, Alford S. T. D., Hinsdale, Ill.
Swezey, G. D., Prof., Crete, Neb.
Porter, W. B., Prof., St. Louis, Mo.
Safford, T. H., Director Astron. Observatory Williams College, Williamstown, Mass.
De Vere, Schele M., LL. D., Prof. University of Virginia, Charlotteville, Va.
Shaler, N. S., A. M., Prof. Harvard University, Cambridge, Mass.
Shipman, Col. S. V., Chicago, Ill.
Steele, Rev. G. M., LL. D., Principal of Wilbraham Seminary, Wilbraham, Mass.
Trumbull, J. H., LL. D., Hartford, Conn.
Van de Warker, Eli, M. D., Syracuse, N. Y.
Verrill, A. E., A. M., Prof. Yale College, New Haven, Conn.
Whitney, W. D., Prof. Yale College, New Haven, Conn,
Winchell, Alex., LL. D., Ann Arbor, Mich.
Winchell, N. H., Prof., Minneapolis, Minn.

HONORARY MEMBERS.

Baird, Spencer F. M., M. D., LL. D., Washington, D. C.
Hamilton, Joseph, Hon., Milwaukee, Wis.

	Eyes in 3 or in 4 rows.	Qu	
		As long or longer than wide.	How much wid than long.
Sandalodes	3	.....	Wider .....
Icius	3	.....	¼ wider .....
Marptusa	3	.....	At least ⅓ .....
Epiblemum	3	.....	.....
Philaeus	3	.....	At least ⅓ .....
Ballus	3	.....	.....
Simætha	3	.....	Much .....
Dendryphantes	3	.....	⅓ .....
Attus	3	.....	Scarcely ⅓ .....
Pellenes	3	.....	⅓ .....
Menemerus	3	.....	¼ or ⅓ .....
Hasarius	3	.....	At least ⅓ .....
Boethus	3	.....	A little .....
Ælurillus	3	.....	At least ⅓ ....
Yllenus	3	.....	At least ⅓ .....
	2		Scarcely ⅓ .....

FAMILY ATTIDÆ.

	POSTERIO
Vertical or rounded.	Slanting, r trunca
ounded.....	Slanting ...
.....	.....
.....	.....
.....	.....
.....	Truncated..
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	...

SLMEPHSDAPMHH
AYMA

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS

EDITED BY THE SECRETARY

VOL. IX, PART II

1893

PUBLISHED BY AUTHORITY OF LAW

MADISON, WISCONSIN
DEMOCRAT PRINTING COMPANY, STATE PRINTER
1893

2

CONTENTS

Page.

Geology of the Waterloo Quartzite Area (with plates VII–IX), by IRA M. BUELL 255

Notes on Cladocera, III (with Plates X–XIII), by E. A. BIRGE 275

On *Bunops sentifrons*, Birge, (with plates XIV–XV), by HARRIET BELL MERRILL 318

Proceedings ..... i–lxix

Report of the Secretary: -

Minutes of the field meeting of 1892 i

Minutes of the 23d annual meeting iv

Report of the Treasurer xiii

Report of the Auditing Committee xiv

Report of the Library Committee xv

Report of the Librarian xvii

Report of the Custodian lxiii

Report of the Committee on Revision of the Constitution lxv

In Memoriam:

Aaron Lucius Chapin, D. D., LL. D., by J. J. Blaisdell lxxi

Philo Romayne Hoy, M. D., by John G. McMynn lxxv

List of Officers and Members lxix

Appendix - Catalog of Library, by WM. H. HOBBS ..... App. 1

Index ..... App. 213

Title page and table of contents of volume IX will be found at the end of this part.